THE WORLD IS ITS FIELD.

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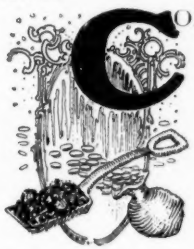
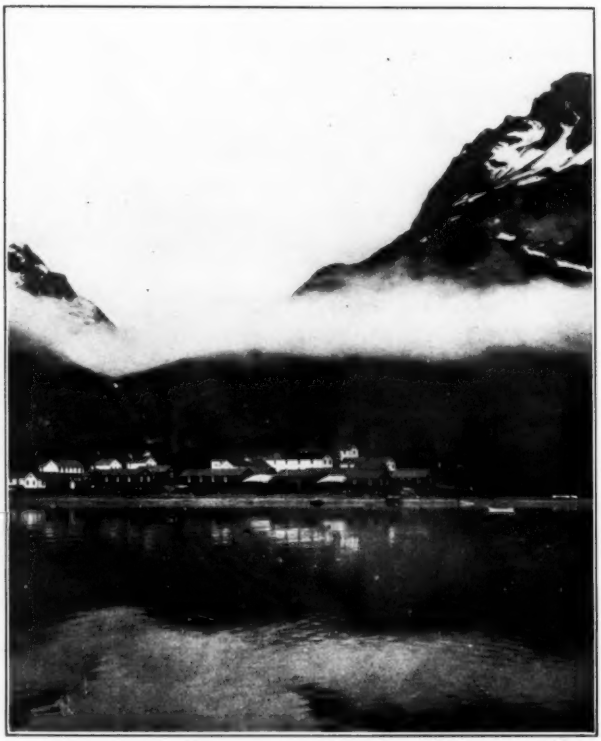
THE COAL RESOURCES OF THE PACIFIC.

By Harrington Emerson.

The development of the Pacific and the determination of its naval and commercial control must depend largely upon the existence of sufficient and available coal supplies. Mr. Emerson has made an exhaustive study of this most important problem, and writes with a close personal knowledge of the subject, knowledge gained by his own familiarity with the Pacific coast and its resources in the course of many professional investigations.—THE EDITORS.



OMMERCE and civilization have passed from the Mediterranean to the Atlantic and perhaps in turn will pass from the Atlantic to the larger ocean, the Pacific. England has been and is the world power in the Atlantic. Her coal mines have furnished the fuel for the sea commerce of the world; her coaling statiors dot the Atlantic shores east and west, in Europe, in the Americas, and in Africa, and from 60 degrees north to 51 degrees south latitude. No other power in Europe can rank with England as a sea power. None has the coal, the coaling stations on all oceans. Russia in extent and number of inhabitants is easily the foremost European land power, but everywhere she is hemmed in from the sea—on the north by the Arctic ice, on the east shut in by the Baltic, on the south shut in by the Black Sea, on the west even until recently closed in by ice. In spite of denials it is readily believed that Russia is willing to foment trouble between Sweden and Norway in order to acquire from the latter a port on the Atlantic, to foment trouble in Turkey in order to take possession of the Golden Horn, to foment trouble in Persia in



FORT LISCUM, PRINCE WILLIAM SOUND, ALASKA

Lat. 61°, long. 147°. At this point begins the military road over the pass to the Copper River. The tarpaulins cover sacks of coal, brought from Tacoma, 1,800 miles southeast.

order to acquire seaboard rights in the Persian Gulf, and we know of present trouble in Eastern waters where thus far Russia has most profited, taking Port Arthur from Japan and Manchuria from China.

Great Britain on the Atlantic—but the United States on the Pacific; the latter destined to become the greater trade ocean of the two. Not only do the most dense and industrious populations of the world line the western shores of the great ocean, but the western coast of North America in natural wealth far surpasses the eastern coast, with the exception of coal; yet if the Crows Nest coal mines of British Columbia, lying on the west slope of the Rocky Mountains and but 500 miles from the Pacific be included in Pacific Coast resources, then in coal also the west surpasses the east; for these measures, many hundred

NUTCHEK BAY, PRINCE WILLIAM SOUND, ALASKA

A United States mail steamer makes the round of the Southern Alaskan coast each month. This part of Alaska is heavily timbered.

miles, in area, contain, in fifteen veins, 150 feet of solid coal, some of it gas coal, some anthracite, and the soft varieties superexcellent coking coal.

In gold the Pacific slope has produced more than all the balance of the United States and last year produced more than all the balance of North America. In fisheries the Pacific coal is easily first, and also in exports of lumber and fruit, if not of cereals.

The general expansion of American interests in the Pacific is exemplified by the fight over the isthmian canals at the extreme east, the judicial scandals at Nome in the extreme north, and the perennial Philippine trouble in the extreme west, not to speak of

the Alaskan boundary, undetermined for 1,200 miles, every foot in dispute, and the payment of the Chinese indemnity. Are not the largest steamers ever designed even now building in Connecticut for traffic between Puget Sound and Japan? Certainly the Pacific Ocean is assuming importance, and modern commercial importance is founded on coal.

INDIAN RIVER, NEAR SITKA

Lat. 57° N., Long. 135° 25'. Sitka is the old Russian capital of Alaska. On this river are spruce trees 8 feet in diameter.

Coal mines and coal fields occur along the Pacific shores, northwest from Chile to Alaska and thence southwest to Australia and New Zealand. The chief geographical difference between the Atlantic and Pacific is that the latter is open to the north, or partially occupied by such worthless regions as Iceland and Greenland, while the whole north Pacific is bounded by Alaska, a region as large as Great Britain, Belgium, Holland, Denmark, Norway, Sweden, and the German Empire, and by good authorities who know it, declared to be richer in natural resources, with the exception of lumber, than all the Pacific Coast States.

Since 1896 five events have occurred that wholly change conditions in Alaska for the better. (1) In that year the Klondike gold discov-

eries were made and in 1897 and 1898 a great rush to and through Alaska began, resulting in a doubling of the population and in an output of gold from the Yukon region to date of $75,000,000. (2) In 1898 the Philippine Islands were acquired by the United States, giving importance to the direct route along the Alaskan coast between North America and the new possessions. (3) In 1899 gold was discovered on the beach at Nome and this carried 30,000 people to this part of Alaska and resulted in an output of $5,000,000 in gold annually, or more than twice as much as all Alaska had previously yielded. (4) The Alaskan salmon fisheries, in their infancy in 1896, have grown in 1902 to great companies, capitalized for $20,000,000 with net earnings last year of more than $2,000,000, and employing 10,000 men. (5) Two railroads have been constructed in Alaska, one of which in the extreme southeast, costing $4,000,000, earned last year over $3,000,000 net, and the other in the extreme northwest near Nome, a little road five miles long which earned $80,000 net. (6) Coal fields formerly superficially known have been explored and investigated, while new ones of great value have been discovered.

The popular impression of Alaska is that it is a far northern region producing gold and intensely cold. The popular impression misses much. Colonel P. A. Ray, U. S. A., late in command of the Department of Alaska, states: "Many have an idea that there is nothing worth going to Alaska for except gold. The same was true of California in 1849, but there are greater resources in Alaska to-day, aside from gold, than in the Pacific Coast States, if timber is left out. There has not been enough told of the diversified possibilities of the country, which if developed would be of greater importance than all the gold." The United States Agricultural Bureau reports over 100,000 square miles adapted to agriculture and grazing.

It is true that on the Yukon near the Arctic Circle there is in winter intense cold, and that the northern shores of Bering Sea are closed each year by ice; but from end to end of the Yukon there is no snow in summer, but long hot summer days. The southern Alaskan coast lies almost due west of British Columbia, and has, owing to the warm winds of the Japan current, a mild and equable climate the year around, the thermometer never reaching zero in winter nor as high as 77 degrees in summer. This is not so surprising, since the Alaskan coast reaches as far south as London, and the towns of Juneau, Sitka, and Dutch Harbor are in the same latitudes as Aberdeen, Edinburgh, and Glasgow, and on a similar coast with a similar climate.

Politically Alaska is important because it borders on three of the

TRIP OF MINE CARS FROM NO. 1 TUNNEL, CROW'S NEST COLLIERY.

great world powers. The boundary between Alaska and Canada is almost as long as the whole of the land boundary between the United States and Canada; Alaska faces Russia across the whole of Bering Sea and the boundaries touch in the Diomede Islands, while the nearest Japanese islands are but 600 miles from the furthest Alaskan islands.

A little understood feature of the North Pacific Ocean is that the shortest steamer route from Panama to Singapore runs very close to San Francisco, to Puget Sound, to the British Columbian cities, to the Alaskan coast and its coal mines, and thence by way of Yokohama, Manila, and Singapore to India, so that the opening of any isthmian canal to traffic will put all the North American western coast cities, as well as Alaska, on the direct and shortest American route from London and New York to the east coast of Asia, all of which can best be seen and understood by stretching a string on a globe, and certainly not perceived by looking at the usual distorted Mercator projection of the world.

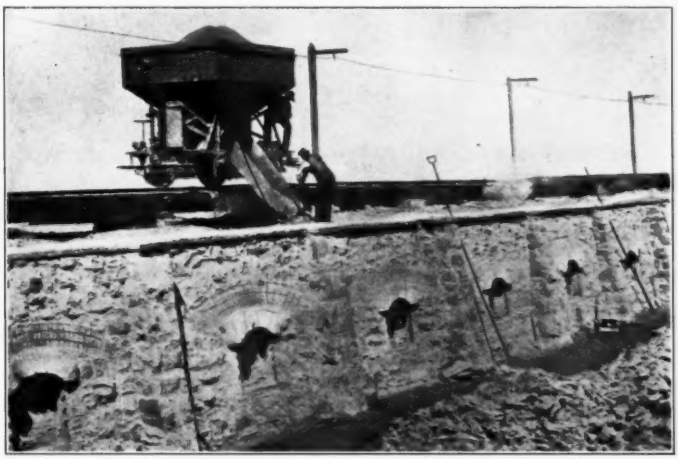
There are now important coal mines at Lota and Coronel in Chili, lat. 38° south, long. 73°, which will, with the straits of Magellan, probably lose their importance when the isthmus is opened, as thereafter all western South American trade will be diverted to the much

shorter and safer route. The Chilean coal, not as good as the Alaskan coals, is very high in sulphur.

The next commercial outcropping of coal on the Pacific occurs at Coos Bay, Oregon, lat. 43° 20′, long. 124° 20′, where the U. S. Government has expended more than $820,000 to make a harbor. The output of this coal in 1900 was 104,294 tons. It is the poorest of all the Pacific commercial coals from Chile to New Zealand, an average analysis being 13.6 moisture, 42.4 volatile matter, 37.4 fixed carbon, 6.6 ash, and 1.54 sulphur.

North of Coos Bay, in that splendid fjord called Puget Sound, and near the cities of Whatcom, Seattle, and Tacoma, in the United States and at Comox and Wellington, on Vancouver Island, occur very extensive coal fields of various qualities of coal. These fields are today the most important on the Pacific and have such an advantage of location that the better and more easily mined coal of the Crows Nest, 500 miles inland, nearly 800 by railroad, can scarcely compete.

In 1901 the output of the American mines was 2,504,190 short tons, an increase of 86,156 tons over 1900, and the output of the Canadian mines in British Columbia, including the Crows Nest (about 300,000 tons), was 1,712,715, an increase of 87,100 tons over 1900. The Vancouver mines were opened as early as 1867, but the American mines have increased in output much more rapidly—145,000 tons in 1880, 525,705 in 1887, 1,330,192 in 1897, and 2,504,190 in 1901; but the opening of the Crows Nest threatens to transfer the supremacy again



ELECTRIC TROLLEY CHARGING COKE OVENS, FERNIE, B. C.

to British Columbia. The best seam in the Wellington colliery is from 5 to 10 feet thick.

Exclusive of Vancouver Island, the Puget Sound coal basin covers an area of about seven hundred and fifty square miles. There are several distinct fields within this basin but the character of the coal

SUMMIT OF WHITE PASS, LOOKING SOUTH TO THE PACIFIC OCEAN

This is the present boundary between Alaska and British Columbia, elevation 2,880 feet, and 14 miles in air line from Dyea Inlet and Skaguay, 20 miles by railroad, which 90 miles further north reaches deep water on the Yukon.

differs in each separate field, varying from a lignite to rich bitumnous coking coals. In percentages, these coals run:

	Moisture.	Volatile.	Fixed Carbon	Ash.
Lignites	8 to 12	35 to 45	30 to 45	6 to 18
Bituminous	1 to 3	25 to 35	45 to 60	2 to 8

Some of these coals make excellent coke. The lignites are hard, bituminous lignites soft but firm, and the bituminous coking coals are soft and require washing.

It is very encouraging to find seams of coal near Alaska 18 feet in thickness, as the seams in the Puget Sound region rarely exceed 7 feet and many of only 30 inches are worked.

Some of the Puget Sound mines seem to produce more tons per employe than any other coal mines in the world. A few years ago world statistics showed that the output per man was:

	TONS.
Japan	87
Belgium	165
France	200
France per miner	280
Germany	260
Great Britain	300
N. S. Wales	400
United States Bituminous	540
United States Anthracite	369
State of Washington, all the mines	514
State of Washington per miner, all the mines	617
State of Washington, Roslyn mine	711
State of Washington, Roslyn mine, per miner	774

Westward from Puget Sound along the coast no coal seams of commercial value are met with until the headwaters of the Yukon River are reached. This river rises only 14 miles from the Pacific Ocean, from which it is separated at the top of the divide by a narrow ridge only a few feet high and wide. At this point the White Pass is 2,885 feet above sea level and is occupied by the White Pass Railroad, which cost $4,000,000 to build from Skaguay to White Horse, a distance of 110 miles, where deep-water navigation on the Yukon begins. Last year the railroad earned $3,000,000 net over operating expenses; it is owned wholly in England, as the English, much more than Americans, have the courage of distant and bold enterprises. In 1901 the freight traffic, 1,000 miles from Seattle to Skaguay, 110 miles to White Horse, over the White Pass 380 miles by Yukon boats to Dawson, was 22,597 tons, and by the lower river, 2,600 miles by sea from Seattle to St. Michaels, 1,600 miles from St. Michaels by river boats to Dawson, was 13,930 tons, both routes showing a gain, of 2,180 tons and 2,303 tons respectively. The fuel for a single freight contract on the lower river cost $50,400.

It is near this White Pass Railroad, in lat. 61°, long. 135°, that a very valuable coal mine has been recently discovered. It is thus described by Mr. Wm. M. Brewer in the *Engineering and Mining Journal:*

"The first discovery was made in a narrow gulch between two high mountains. The first outcrop, which represents the lower seam opened, on which work as done, is about 5 feet in thickness. A short tunnel was driven

COAL HARBOR, SOUTH SHORE HERENDEEN BAY, ALASKA

The outcrops of coal occur in the little valley in the foreground, about two miles from the sea and at an elevation of 800 feet.

on this, and the coal found to lie beteen a slate roof and a conglomerate floor. About 300 feet higher another seam outcropped, about 18 feet in thickness. On this a tunnel was run 60 feet in length. The coal lay between a slate hanging-wall or roof and shale foot-wall or floor. A sample of this coal, which is very free from slate, was hauled over the snow last winter to White Horse, and tested on the engines of the railway company. The superintendent of the railroad informed the writer that this test was very satisfactory, and the steaming qualities of the road were fully determined. The third outcrop, which may belong to a still higher seam or may be the same seam as the second mentioned, was discovered on the plateau apex of a mountain 700 feet higher than the gulch in which the two first outcrops were discovered, and easterly about half-a-mile distant. This outcrop had been opened by a shallow crosscut which exposed the seam 18 feet in thickness having the same line of strike, but dipping about 20° nearer the vertical than the other outcrops. A survey for a tram track from the railway has been made by J. E. Beatty, assistant engineer for the White Pass & Yukon Railway Company, and all arrangements perfected to organize a company to acquire 1,500 acres of this coal field. The route followed by the survey line is through a comparatively easy country, to construct a narrow-gauge line of railway."

With one exception none of the other Pacific coast coal mines are as far north as this and none of them in so rigorous a climate. Westwards along the coast there are outcroppings of coal at Lituya Bay, at Yakutat and on the flanks of Mt. St. Elias, but the first field that promises to be of great commercial importance is one very recently discovered near the Chilkat River between Mt. St. Elias and the mouth of the Copper River, lat. 60° 20′, long. 144° 30′. This coal is extraordinarily good, as clean to touch as glass and almost identical in composition with Albion Cardiff, Glamorganshire, Wales, adopted by the United States Bureau of Equipment as a standard:

	Moisture.	Volatile.	Fixed Carbon.	Ash.
Albion Cardiff.....	0.352	14.	82.44	0.06
Alaskan Kyak.....	0.77	13.79	82.36	3.08

I have not seen the seams, but they are credibly reported as being very extensive and of great thickness. They are being developed by a strong English company, who, however, will find it an expensive undertaking to bring the coal down to a suitable loading harbor owing to the mountainous character of the country and the failure of nature to provide a protected roadstead near the mine. In the same region the same company has extensive petroleum deposits and wells, the oil containing no sulphur. It is a cause for congratulation that Alaska has produced better coal than any other coal anywhere on the Pacific Ocean, coal almost equal to the best in the world.

The next commercial occurrence of coal is in the Kenai Peninsula in Cook's Inlet, a deep sound discovered by Cook in 1787, left unnamed by him, but named after his death by Lord Sandwich. Here the coal for scores of miles crops out in numerous seams along the ocean front, and at low tide is loaded into small boats. Much of it is very lignitic, light and brittle in character, but burns well. At one single point a long sand spit juts out into Kachemak Bay where the tides rise 30 feet and this makes the only available harbor, lat 59° 40′, long. 151° 30′. Mr. Geo. Jamme, Jr., of Pittsburg, had charge of the opening up of this mine. He built 7 miles of railroad and a fine dock to bring the coal from a great level basin lying a short distance inward from the ocean front. Unfortunately the company working this mine has no ocean transportation equipment and is thus

OLDEST RUSSIAN BLOCK HOUSE IN ALASKA, AT NUTCHEK

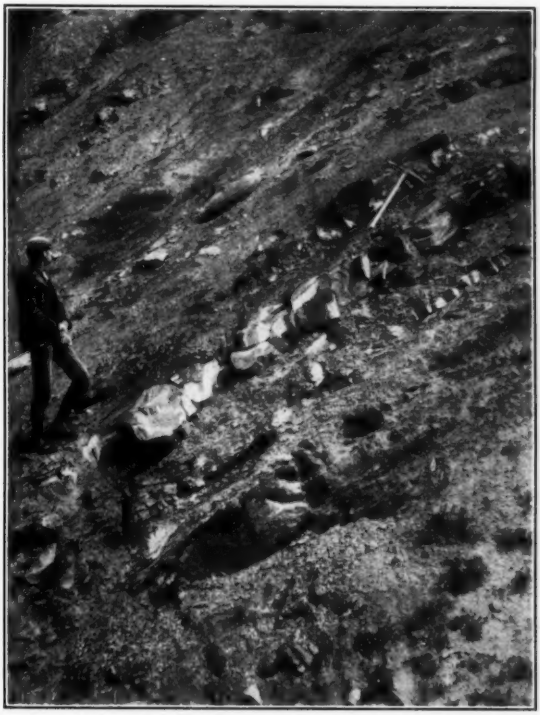
Nutchek, lat. 60° 15′, long. 147°, is at the entrance to Prince William's Sound, explored and named by Capt. Cook, in 1778. These block houses took several years to build and are fastened with hand-forged copper or iron nails brought from Russia.

severely handicapped. Local settlements, fishing steamers, etc., quarry their own coal at low tide along the beach at merely nominal expense, while a few hundred miles away coal is selling at $12 to $20 a ton. The location of this mine is such as not to enable it to compete with other Alaskan mines in Bering Sea markets where a very large demand exists at a very high price, running from $10 to $100 per ton.

The question of harbor is always an important one on the American Pacific coast, where even in the calmest summer weather the surge of the Pacific beats angrily on the rocky American shore. With the drive of a storm the waves gain in height all the way from Japan, and break with indescribable fury against the American coast. The har-

OLD TUNNEL INTO ALASKAN COAL MINE

This tunnel was opened ten years ago and about 1,000 tons of coal mined with the expectation of supplying San Francisco, but it proved at that time more profitable to use the equipment in a neighboring gold mine.

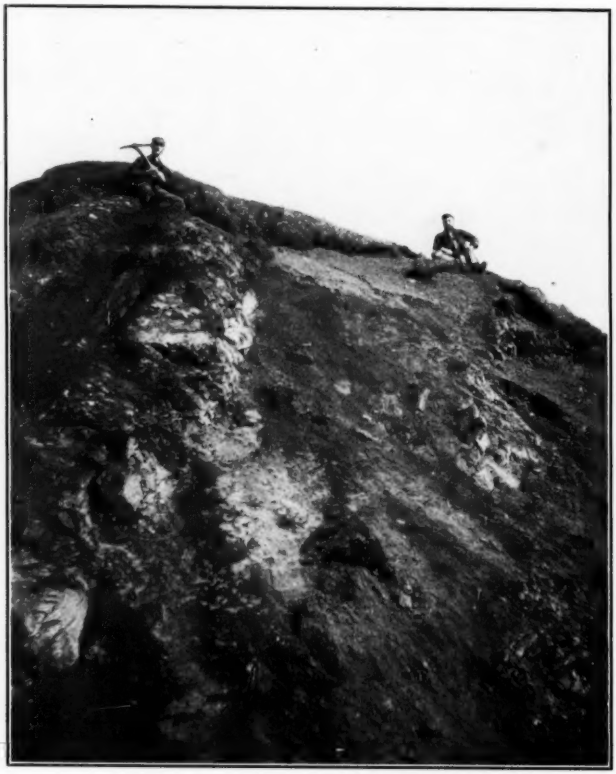


AN OUTCROPPING OF COAL

The upper pick tip points to the top. The seam is 47 inches thick at outcrop and 53 inches thick at the end of a drift 97 feet long.

bors of the coal fields of Puget Sound and Vancouver Island are admirably protected from storms, but the Kyak coal has no natural harbor, and this is true of many of the Alaskan coal fields.

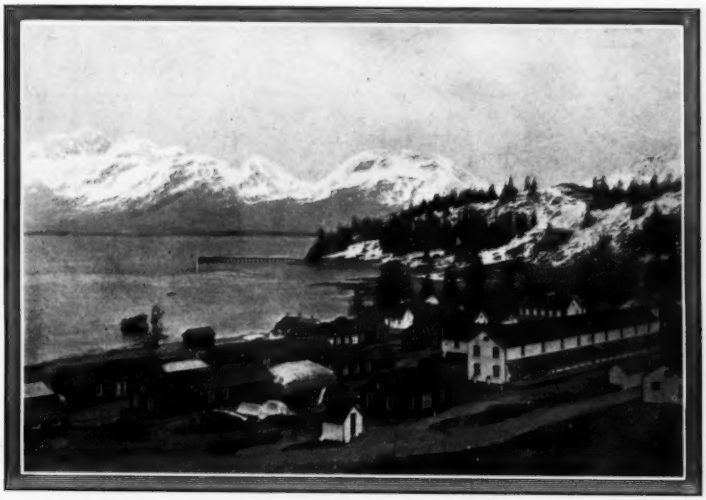
Westward from Kenai, the greatest and most extensive coal field in Alaska is reached, cropping out in many different seams, in two harbors on the Pacific and one on Bering Sea. These Chignik-Unga-Herendeen Bay coal measures, lat. 55° 30′ to 56° 30′, long. 158° to 161°, are not only the most extensive and most accessible fields in Alaska with coal in quality next to that of Kyak, but fully equal to any coal mined further south. The specific gravity runs from 1.33 to 1.49; the coal is hard, brilliant, clean and very strong, not crumbling under severe exposures to water, frost, or sun, nor with very rough usage. This field is of unique value because of its location in the key-



A BERING SEA HILL TOP, COVERED WITH TUNDRA

Each man is sitting on an outcropping coal seam. The tundra is broken by mud patches into which one can sink knee-deep.

stone of the North Pacific. Not only does the shortest possible steamer line from the United States or British Columbia to any part of Asia run within 20 miles of this field, but it is also the nearest of all American coal mines to all the island possessions of the United States on the Pacific, the nearest part of the American mainland to Hawaii, to Samoa, to Guam, and to the Philippines, and also by nearly 2,000 miles nearer than the Puget Sound mines or San Francisco to all parts of Asia, and especially to the great mining region recently developed on the shores of Bering Sea. There is a market to-day on the shores of Bering Sea, according to the United States census agent in Alaska for 1890 and 1900, for 80,000 tons of coal at prices from $10 to



SACKS OF COAL AT FORT LISCUM, PRINCE WILLIAM SOUND, ALASKA

The pile of sacks is in the left middle ground between two buildings and covered over with a white tarpaulin.

$30 a ton at lowest, ranging upwards to $75 a ton. The consumption in Hawaii is 150,000 tons, and the conditions are such that this coal can be competitively exported southeastward for the Californian, Mexican, and Central American markets, and southwestward to the Philippine Islands, for the Japanese go further, even to India, with coal of poorer quality.

DISTANCES IN NAUTICAL MILES FROM

	Chignik-Unga. Herendeen Bay.	Seattle.	San Francisco.
Dutch Harbor to	240	1,702	2,035
Yokohama to	2,726	4,280	5,500* / 4,581†
Philippine Islands to	4,507	5,972	6,855* / 6,370†
Honolulu to	2,066	2,410	2,100
Guam to	3,580	4,943	5,437* / 5,430†
Nome to	550	2,362	2,770
St. Michaels to	540	2,360	2,760

*Via Honolulu. †Via Portage Bay.

From the above figures taken from maps, charts, and statements furnished by the United States Coast and Geodetic Survey, Department of the Treasury, and by the Hydrographic Office, Department of the Navy, it is apparent that:—from Seattle to Yokohama via Portage

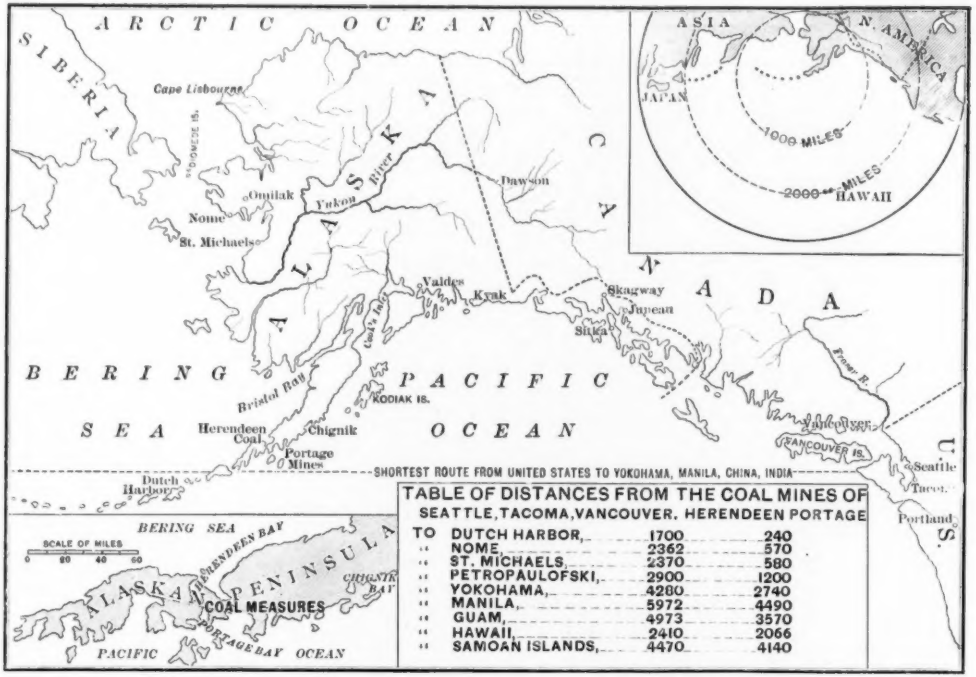


TABLE OF DISTANCES FROM THE COAL MINES OF SEATTLE, TACOMA, VANCOUVER, HERENDEEN PORTAGE

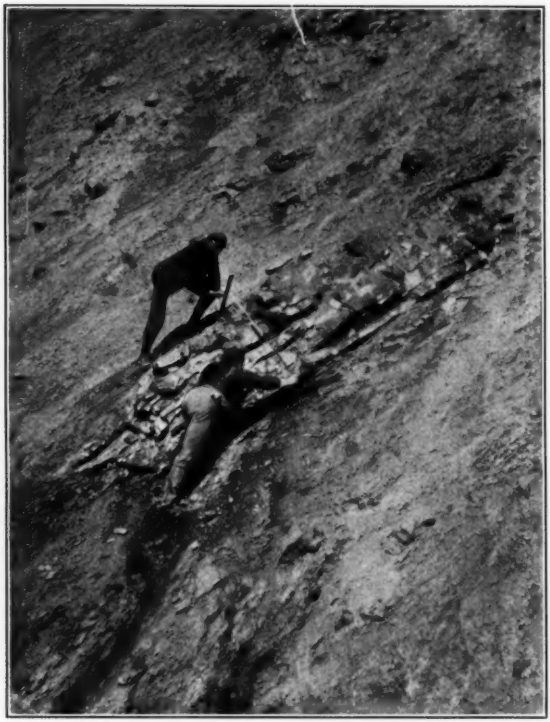
TO	DUTCH HARBOR,	1700	240
"	NOME,	2362	570
"	ST. MICHAELS,	2370	580
"	PETROPAULOFSKI,	2900	1200
"	YOKOHAMA,	4280	2740
"	MANILA,	5972	4490
"	GUAM,	4973	3570
"	HAWAII,	2410	2066
"	SAMOAN ISLANDS,	4470	4140

MAP SHOWING THE ALASKAN REGION AND COMPARATIVE DISTANCES FROM THE COLUMBIA RIVER AND HERENDEEN PORTAGE TO THE PRINCIPAL PORTS OF THE PACIFIC

COAL HARBOR, NORTH SHORE HERENDEEN BAY, ALASKA
Herendeen Bay is the largest and safest harbor on Bering Sea.

Bay, Alaska, is 72 miles longer than the shortest possible route. From Seattle to Manila via Portage Bay is only 25 miles longer than shortest possible route. From San Francisco to Yokohama via Portage Bay is 919 miles shorter than via Honolulu. From San Francisco to Manila via Portage Bay is 485 miles shorter than via Honolulu. From Portage Bay it is 1,482 miles shorter to Manila, 1,403 miles shorter to Guam, 344 miles shorter to Honolulu, and from Herendeen Bay, 1,460 miles shorter to Dutch Harbor, 1,790 miles shorter to St. Michael's, 1,792 miles shorter to Nome, than from the coal supplies of Seattle, Tacoma, and Vancouver.

Herendeen Bay is in many respects a counterpart of New York Bay—a Sandy Hook surrounded by shallows, a Coney Island beach where great herds of walrus bask, a Staten Island protecting the mouth of the harbor, narrows leading into a great deep bay, wholly



MEASURING AN ALASKAN COAL SEAM

An outcropping of coal on the side of a gulch above Herendeen Bay.

protected, with ten square miles of water from 60 to 200 feet deep; but the climate is warmer in winter in Herendeen Bay than at New York.

At a point 800 feet above the sea level, only two miles from the best anchorage, coal crops out in thirteen seams of which the best five are 43, 30, 55, 45 and 43 inches thick. Other seams not yet explored are reported seven and eight feet in thickness. With modern equipment it ought to be possible to deliver this coal in deep-sea vessels at any time of the year for one dollar a ton, making it the cheapest seaboard coal in the world. The calorific value from a sample from one of the veins, by no means the best, as determined by the Pittsburg Testing Laboratory, was 12,692 B. T. U.

Herendeen Bay opens on Bering Sea and this makes this mine but half as far from Nome and St. Michael's as any other work-

able coal mine. The seams near Chignik Bay and on Unga Island open on the Pacific. The latter have been worked in a small way for sixteen years by Mr. H. S. Tibbey, but until the recent growth of Alaska the market, though high-priced, was small. This year Mr. Tibbey is putting in $50,000 worth of machinery and will receive the just reward of his faith and patience. At Unga, as elsewhere in Alaska, Washington, and Vancouver Island, there are various seams of varying quality. Some of them are lignitic and contain consider-

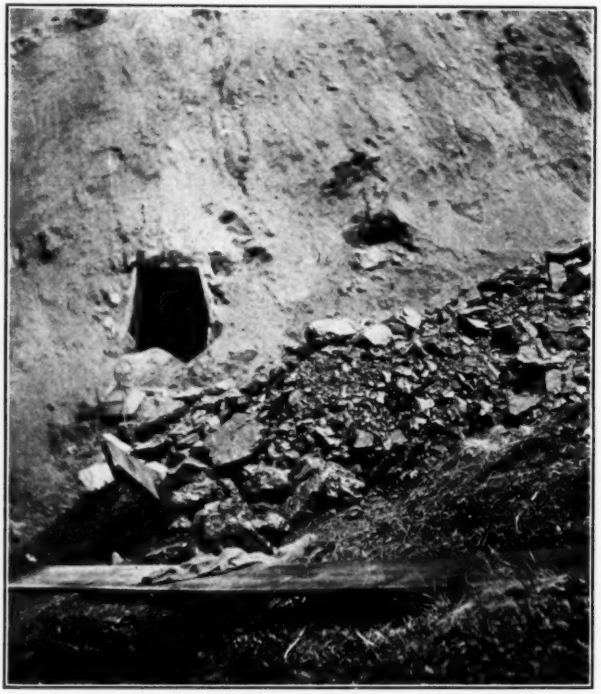
A MINER'S CABIN AND TOOL HOUSE NEAR HERENDEEN BAY

In front of the cabin is a pile of coal. All the lumber for this cabin was brought 2,000 miles and carried on men's backs over a mountain path 1,000 feet high. The summers are cool, the winters less severe than at Philadelphia.

able sulphur, others are of excellent quality. At Chignik the seams outcrop from 5 to 7 feet in thickness and from 2 to 5 miles from the sea.

One hundred and fifty miles west of Herendeen Bay and Unga the American continent ends. North of Bering Strait, in the Arctic Ocean, lat. 69° long. 166°, at Cape Lisborne, is a very extensive field of excellent coal, but of commercial importance owing only to the enormous price ($75 a ton) the few cargoes shipped to Nome have

realized. Bering Strait is closed nine months in the year by ice, the coal crops out on an unprotected stormy ocean front, and conditions of operation must always be prohibitively expensive, there being as much difference in climate and distance between Herendeen Bay and Cape Nome as between New York and the shores of Hudson Bay.



RECENT TUNNEL INTO NEWLY DISCOVERED COAL SEAM ON HERENDEEN BAY
Lat. 55° 45' N., long. 160° 40'. At the end of tunnel, seam is 53 inches thick. Pile of coal in foreground.

The North Pacific Ocean coal mines on the American side produced in 1901, on Puget Sound, 2,504,190 tons, and in British Columbia about 1,712,715 tons, a total of 4,216,905. The consumption of coal is approximately:

Along the Mexican Coast and Central America....	200,000 tons
In California	2,000,000 tons
In the Hawaiian Islands.....	150,000 tons
In Alaska	100,000 tons
Locally in Oregon, Washington and British Columbia, including steamers and railroads.....	2,217,000 tons
Total.....	4,667,000 tons

FLOAT COAL IN AN ALASKAN STREAM

The shovel rests on a big lump of coal which has fallen from an outcrop and rolled down the stream. Alaska is so little explored that coal and other minerals are only discovered by outcrops or float in the streams and valleys.

The difference of 450,000 tons is made up by importations from Wales, Australia, and the Atlantic seaboard.

Owing to improving conditions and increasing demand all the Pacific coal mines, whether in Australia, Japan, British Columbia or Washington, are prosperously increasing their output with no apprehension of any overstocking of the market. In Hawaii, coal consumption has doubled in five years, and in the State of Washington the increase has already been noted. The great discoveries of oil in California have prevented a similar increase in coal consumption there, yet imports have not fallen off and twice at least within the last three years San Francisco has suffered from a coal famine.

In this review of the American Pacific coals, the Japanese, Chinese, Australian and New Zealand coals will be mentioned only in the table of comparative analyses furnished by the United States Government.

With isthmian concessions near the equator, with great gold, copper, silver and lead mines near the Arctic circle, with a vision of American ships steaming from New York to Manila, via San Francisco, Seattle and Tacoma, Dutch Harbor, and Yokohama, coaling at American coal mines all the way, the United States, while yielding to England supremacy in the Atlantic from the Orkneys to the Falkland Islands, can gather to herself the immeasurably greater trade possibilities of the whole American and Asiatic Pacific coast, along which her own continental seaboard extends 4,000 miles and her outlying possessions from equator to Arctic Ocean and back again to equator.

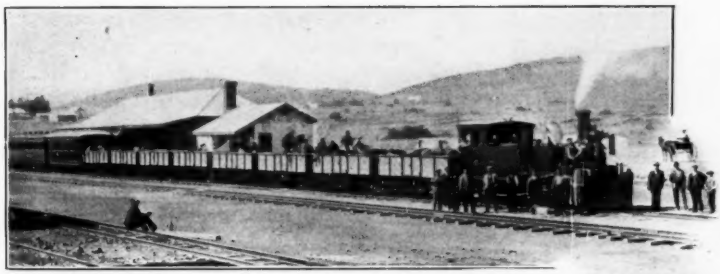
ANALYSIS OF THE PACIFIC OCEAN COALS.

Commercial Name.	Location.	Moisture.	Volatile.	Fixed Carbon.	Ash.	Sulphur.
*Albion Cardiff	Wales	.352	14.	82.44	.06	.06
Lota	Chile	3.9	34.49	58.76	2.85	3.4
Newport	Coos Bay, Oregon	13.69	42.44	37.35	6.61	1.54
Blue Canyon	Washington	1.79	31.48	62.74	3.68	.38
Wilkeson	Washington	.7	23.54	56.90	18.71	.14
Roslyn	Washington	1.45	32.8	53.66	11.94	.15
Comox†	Vancouver Island	1.1	20.19	69.75	8.06	.53
New Vancouver,	Vancouver Island	2.78	35.1	56.95	6.66	.25
Wellington	Vancouver Island	1.82	29.9	52.6	15.	.66
Nanaimo	Vancouver Island	3.35	35.76	46.	14.32	.17
Kyak, Controller Bay	Alaska	.77	13.79	82.36	3.08	
Homer	Kachemak Bay, Alaska	1.25	39.87	49.89	7.82	1.2
Herendeen Bay	Alaska	3.22	30.78	60.52	5.48	.4
Herendeen Bay ... Seam 2,	Alaska	4.37	39.35	53.23	6.08	.5
Yokoshima, best	Japan	1.44	38.31	55.22	5.03	.08
Yoshinstani, poorest	Japan	2.52	38.12	49.95	9.41	.7
Kaiping	China	.66	24.14	61.92	13.28	.6
Labuan	Borneo	6.	39.45	51.1	3.44	1.46
South Bulli, N. S. W...	Australia	.89	21.3	66.91	10.35	.41
Newcastle, N. S. W.	Australia	2.39	33.64	57.55	6.42	.15
Gravity Creek	New Zealand	1.01	34.	62.23	2.77	.45
Hikwiangi	New Zealand	6.05	39.63	49.29	5.03	3.18

* The Standard of the Bureau of Equipment, U. S. N.

† This shaft now closed.

In the mighty and unsubdued Alaska the explorer, prospector, or engineer is dependent on kindly help. In my Alaskan expeditions I received willing co-operation and support from the director and members of the Coast and Geodetic Survey, of the Geological Survey, of the Land Department, of the Fish Commission, from army and navy and treasury officers, from the governor of Alaska and United States officials at Sitka and Dutch Harbor, from the Pacific Coast Steamship Company, from the Pacific Steam Whaling Company, from the Alaskan Trading Companies and from the owners of the coal seams in Southeastern Alaska, at Yakutat, Controller Bay, Homer, Amalik, Chignik, Unga Island, Herendeen Bay and Cape Lisbourne, nor am I less indebted to the prospectors and miners whose tents and fare I shared on the shores of Bering Sea.



THE FIRST TRAIN OVER THE PRETORIA-PIETERSBURG RAILWAY.

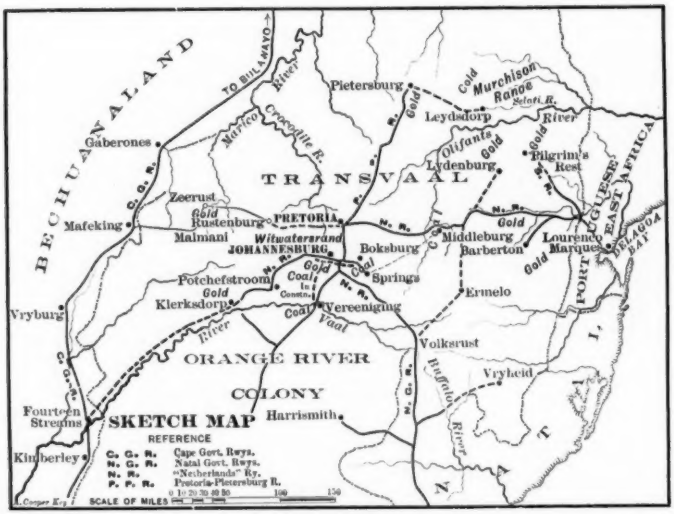
RAILWAY DEVELOPMENT IN FEDERATED SOUTH AFRICA.

By A. Cooper Key.

Newspaper dispatches from South Africa show that the labor market in Johannesburg is already over-supplied with men who have gone there in search of work in the mining industry; important discoveries of new copper and iron fields are announced; and there is no doubt that the enterprising spirits of the Anglo-Saxon race from all parts of the world will be flocking to South Africa so soon as stable conditions are promised. All Britain is interested in and committed to the development of South Africa, and in the light of all these facts Mr. Key's review of the railway situation—the basis of all development—is both timely and important.—THE EDITORS.

THERE is ample scope for railway construction in the Transvaal region. Formerly this was in large measure prevented by the restrictive treaty between the late governments of the South African Republic and the Orange Free State. By this convention the Transvaal agreed not to make railway extensions westward except with the consent of the Orange government. For had the Netherlands Railway been connected with the Cape system on the west side of the Transvaal, the whole of the passenger traffic to Cape Town and large portions of goods traffic to Port Elizabeth would have been diverted from the main line of the Free State government.

With federated South Africa, we shall probably have a federated system of railways in the sub-continent. Until that consummation, similar objections to railway extension will be continually cropping up. New schemes will clash with vested interests. A new railway policy must be so framed as not to injure and impoverish existing lines. The



railway through the Orange River Colony will form a very valuable revenue-earning asset of the new administration. The pros and cons of any scheme which would diminish this revenue capacity must be carefully considered beforehand. For instance, a line from Klerksdorp to Kimberley is an obvious extension in the general scheme of development. Would it be wise to construct it in view of the interests of the Orange River Colony? Do the demands of greater South Africa overrate the interests of the single colony?

At present the line through the Orange Colony carries all the traffic to the Vaal Colony from Cape Town, Port Elizabeth, and East London. These three systems—the western, the midland and the eastern of the Cape Government Railways pour their traffic—passengers chiefly from the western, goods mainly from the midland and eastern—onto the main Orange River Colony line at Norval's Pont or Springfontein. For some time before the war the fact that this single line of 333 miles was inadequate to the demand made upon it was amply demonstrated. Indeed, a wholesale extension of crossing sidings was decided upon, to be followed eventually by a doubling of the line for considerable lengths.

Ever since it was constructed in 1892 by the Cape government as the northern section of the railway system, the line from the Orange River bridge to Mid Vaal River bridge (to give the official names) has been remarkable for its revenue capacity and earning power. In 1892

the net receipts were equal to £9.11.3 per cent. on the invested capital, in 1893 to £8.19.1 per cent., in 1894 £10.11.6 per cent., in 1895 £14.14.0 per cent., and in 1896 to £15.12.0 per cent. Then the line passed into the control of the Orange Free State government.

With the pacification of South Africa there is bound to be a tremendous accession of trade, traffic, industrial activity. The traffic from Cape ports to the Transvaal has demanded some improvement in carrying capacity from the end of the Cape system. In the future this demand will be all the more insistent. Of course the first obvious remedy is to double the Orange River main line throughout. But are there not better remedies? Cannot new tracks be opened up without grave disadvantage to the old route? Would it not be wiser to defer this widening, and instead make a new line from Klerksdorp to Fourteen Streams, 50 miles north of Kimberley on the western section of the Cape lines? As the crow flies the actual distance is about 140 miles, and the engineering detours which would probably be found necessary should not increase this to more than 150 miles. The cost of this new

THE RAILWAY STATION AT PRETORIA.

construction should not greatly exceed that of doubling nearly 350 miles in the Orange River Colony. Besides possessing important military advantages—and for a while it will certainly be necessary to have an eye to these—this new line would give the shortest route between Cape Town and Johannesburg. Between these two places is probably the most valuable through passenger traffic in South Africa. By this new line the distance between the two industrial capitals of South Africa, Johannesburg and Kimberley, would be reduced to about 300 miles. At present a traveller wishing to go from the Rand to the Diamond City is obliged to travel due south to Naauwpoort Junction (435

miles) then north-west to join the western system at De Aar (85 miles) then north to Kimberley (140 miles). Thus the total distance from Johannesburg is 660 miles. The republics might set their faces against railway developments which would have shortened such circuitous routes as these. But these and like anomalies will be swept away now the development of the sub-continent is being carried out under Imperial British auspices, now British brains will have something to say in respect of new schemes and development.

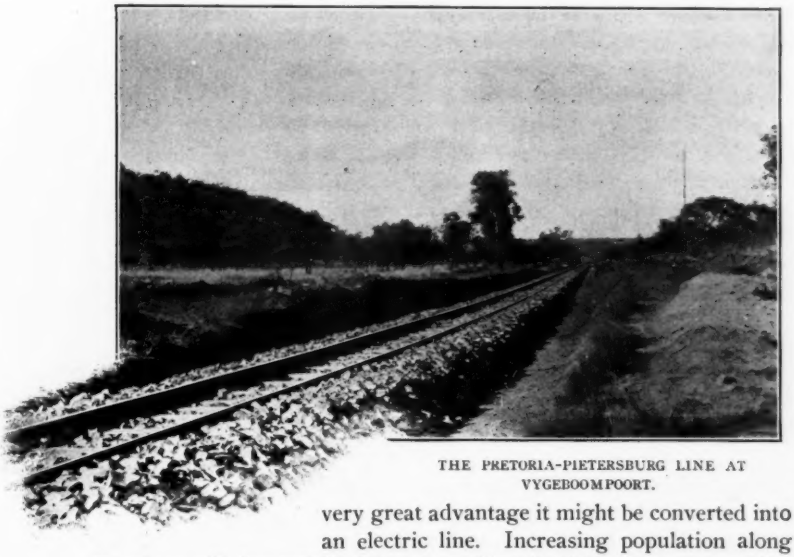
In my estimation the construction of the Klerksdorp-Fourteen Streams line comes within the class of lines of primary importance. For years it has been proposed to build a new line south of the existing one along the mines from Boksburg to the west of Johannesburg. The Rand Tram, as it was originally styled, can only be called moderately convenient as regards supply of coal and stores to the gold mines. For the convenience of the deep-level and second deep-level companies a new line about a mile to the south is required.* Indeed, it

WARMBATH STATION. A TYPICAL BUILDING ON THE PRETORIA-PIETERSBURG LINE.

is not looking too far ahead to express the opinion that before many years have passed a third line will be imperative for the economical development of the deepest-level areas. Both these lines would deal almost exclusively with coal, goods, and general-supply traffic for the mines. Passenger traffic, if any, would be meagre. Some of the outcrop mines would be more conveniently served by the new southern line than the present one.

The existing line from Krugersdorp on the west to Boksburg on the east, traversing the principal mines and extending to a distance of about 40 miles, might be reserved mainly for passenger traffic. With

* This line has been in part graded by the military authorities.



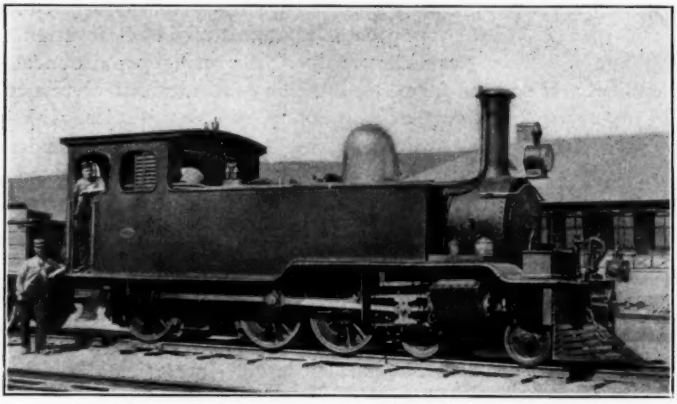
THE PRETORIA-PIETERSBURG LINE AT VYGEBOOM POORT.

very great advantage it might be converted into an electric line. Increasing population along the mines will demand far better travelling facilities than were available in the past. A regular half-hourly stopping service, with the addition of hourly fast trains stopping only at Boksburg, Elandsfontein, Jeppes Town, Johannesburg, Roodepoort and Krugersdorp, would probably prove adequate and satisfactory for some time to come. Locomotive and passenger stock "released" when the electric-traction arrangements were completed could be transferred to the new lines. At Brakpan, a few miles beyond Boksburg, the Rand Central Electric Works have had established for some years a large plant supplying current along the reef. Power for the electric line here suggested could be obtained by largely increasing the plant of that company, a course likely to be as convenient as any other.

Among railways projected by the late government was one from the farming and tobacco-growing district of Rustenburg to Pretoria. When the line was under discussion the general feeling in Johannesburg was that it would have been preferable to have brought it to the mining centre than to the government capital. Both objectives have special points of merit, and of course Johannesburg forms distinctly a larger produce market than Pretoria. With the changed circumstances of the country it may be deemed better to carry the line (should its construction be decided upon) to Pretoria. This would give a

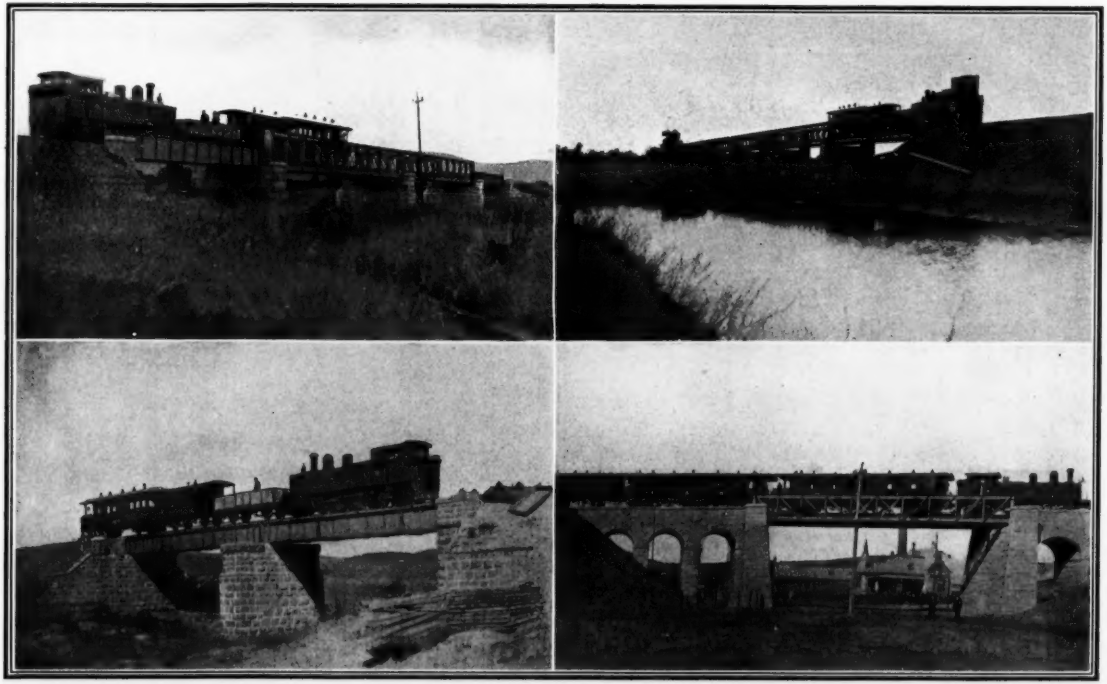
direct connection with the line thence to Middelburg and Delagoa Bay. Moreover, the military advantage of this route as giving a portion of a second east-and-west iron road through the new colony, to be completed as mentioned below, must not be ignored. Volksrust-Johannesburg-Klerksdorp is the first or southern of these east-to-west branches already constructed and to be completed by the proposed line to Fourteen Streams on the Cape Colonial border. Eventually the Rustenburg line could be extended through Zeerust, Ottoshoop, Malmani to join the Cape line at Mafeking.

There is no necessity, for the present at any rate, to canvass the question of northward extension of the Pretoria-Pietersburg line beyond Pietersburg. Industrially or agriculturally there are no reasons for such a step. What would be advisable, however, would be to prolong the line eastward to Leydsdorp, through the Haenertsburg gold area. This course would be preferable to carrying out the original scheme of the Selati Railway, which, commencing at Komati Poort had its objective at Leydsdorp.



AN ENGINE ON THE PRETORIA-PIETERSBURG RAILWAY.

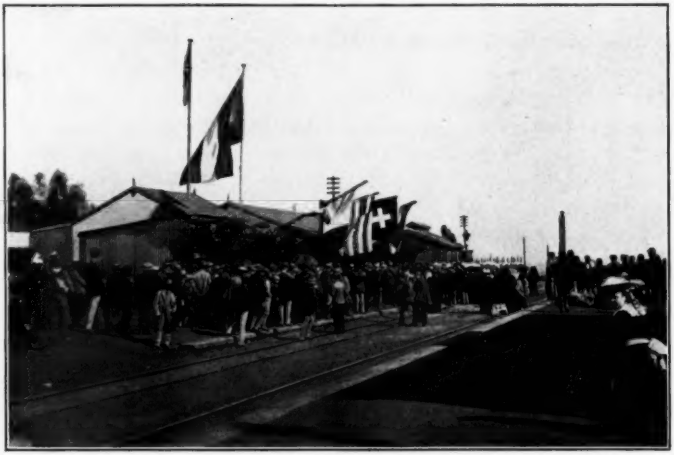
It is not necessary here to advert at length to the disastrous history of the Northern Railway of the South African Republic, or Selati Railway. Of the 217 miles, only 71 have been completed and it has never been utilised for traffic for the simple reason its terminus was "nowhere." But the portion of line already constructed can be utilised as part of a route to the Pilgrim's Rest gold field, lying somewhat north-east of Lydenburg, to which railway communication will doubtless be given by means of a junction with the eastern line of the Netherlands Railway either at Belfast or Machadodorp. Such a line was



BRIDGES ON THE PRETORIA-PIETERSBURG RAILWAY.

Above on the left is the Aapies River bridge; to the right of it, the bridge over Pienaar's River; on the left below, the Groot Nyl bridge, and on the right, the bridge over Potgieter street, taken as the first train was crossing it.

proposed by the late government. Lydenburg is the centre of an important gold-bearing region, being the second in point of output in the Transvaal. Undoubtedly the mining prospects are good—perhaps better than those of any other outside district in the new colony.



THE OLD PARK STATION, JOHANNESBURG, NOW A THING OF THE PAST.
Waiting for the visit of Sir Hercules Robinson.

Some time before the war commenced the government of the South African Republic granted a concession to a private company for a line from Ermelo to Machadodorp on the Delagoa Bay line, a distance of some 65 miles. *En route* this line would open up important coal fields in the district of Carolina. It has hitherto been impossible to exploit this coal field remuneratively owing to the absence of railway facilities. That there is a future before it is unquestionable, as the coal in parts is considered superior to the product of the Middelburg mines generally conceded to be the best coal used in the country. With its terminus at Ermelo the utility of the projected line is not great. It would be of marked advantage to continue the line southward for 60 miles or so in order to form a junction with the Johannesburg-Charleston (Natal) line somewhere between Standerton and Volksrust. Besides giving a very fair route—"excellent" compared with the existing one—between Durban and Lydenburg and Barberton, it would form a second north-and-south line directly connected with Natal as the other with the Cape. As such its advantage and point for military purposes will not be lost sight of. This line south of the Delagoa Bay railway should connect directly with that on the north of it to Lydenburg.

For some years people interested in the development of the Middelburg coal district have advocated the construction of a line from Boksburg, in the East Rand to Balmoral a few miles west of Middelburg town. This would avoid the long detour through Pretoria and enable their coal to be put on the Rand market at a cheaper rate. The point that it would open up other coal fields *en route* has not been accorded the importance it deserves by the Middelburg owners, who would be the first to feel the effects of exploitation of newer areas nearer the Rand market. Though this line would be useful, particularly as shortening the distance from the Rand to Delagoa Bay, its construction cannot be regarded as of prime necessity.

In the extreme south-east corner of the Transvaal it is proposed to connect Vryheid, formerly the capital of the new republic, with the Natal system at Dundee. The line from Dundee to the Buffalo River is under construction by the Natal government, while that on the north had been commenced (as a State line) by the late government of the South African Republic. From Vryheid to Buffalo River is 39 miles and the contract was let for £292,000.

THE PRESENT PARK STATION, JOHANNESBURG.
(Copyright by Barnett.)

Either immediately or in the near future, nearly all the lines mentioned will form part of trunk routes, and this is in itself sufficient reason for the adoption of the normal gauge of South Africa, viz., 3 feet 6 inches. Where land can be taken free of cost, and with fairly cheap labour, the cost of building standard lines should not really be much in excess of that for light lines of 2 feet 6 inches or less. The experi-

ences of the narrow 2-feet gauge adopted at first on the Beira Railway has been such as would surely prevent its serious consideration elsewhere. Of course it must be remembered the Beira line is a "severe" one, having a ruling gradient of 1 in 50 with four-chain curves. In a report of a few years back, Mr. Elliot, general manager of the Cape Government Railways, records that only 20 tons per day could be hauled on the narrow-gauge Beira line as compared with 160 tons on one of normal gauge. Three days instead of one were required for the transport of goods on the 220 miles from Beira to Umtali on account of the restricted speed of the locomotive. Eight times as many trains were required, greatly hindering the working of the line. Indeed, no less than 72 "men-days" were required for a load of 160 tons, which could have been taken by three men (one driver, one stoker and one guard) in a day on the Cape Colonial system. Mr. Elliot added the opinion that with more modern locomotives better results might be obtained. Even so, narrow-gauge lines of 2 feet and 2 feet 6 inches will prove unsatisfactory. Why, the 3 feet 6 inches gauge has been found inconveniently narrow! Competent and influential engineers, among them Mr. Theodore Reunert, of the well-known Johannesburg firm of Reunert & Lenz, have indeed discussed the advisability of increasing the gauge of the existing main lines of the Cape Colony. But this would in all likelihood be found out of the question on the score of expense. In spite of experience elsewhere and against the consensus of engineering opinion, the Cape government has in certain new lines "sanctioned a departure from the principle that all railways should be of 3 feet 6 inches gauge." America is teaching the management of English railways the economy of full well-laden trains hauled by the most powerful locomotives. Needless to say that idea is not consonant with the provision of light narrow-gauge lines.

In the foregoing sketch of a scheme of railway development for the Transvaal no attempt at any hard-and-fast exhaustive plan has been put forth. Regard has, moreover, been had to the requirements of the immediate future. For instance, in time to come, as the country develops, it may be necessary to have a direct route from the Rand to Rhodesia. But for years the projected extension of the Rustenburg line to Mafeking should meet every requirement of the industrial population. By over six hundred miles would it reduce those longest railway journeys in South Africa—from Durban to Bulawayo and Lourenço Marques to Bulawayo. It will be seen that in the schemes put forward military requirements are not lost sight of. As it happens, both industrial and military demands, or military and industrial de-

mands, whichever takes the first place, are fairly met by the same new railways. There would be two parallel lines running north-and-south and two east-and-west. By means of these troops could be rapidly moved to any centre of disturbance in the southern half of the new colony. The wilds of the northern districts are left alone, but this district is so rugged and mountainous, so thinly populated, that no new railways can be advocated from an economic standpoint. Any lines far north of Pietersburg would be tremendously costly to construct, and could only be taken in hand under the sternest military requirements. Let us hope they will not be necessary.

In the tables below will be found a schedule of the existing lines in the Transvaal and one of those sketched in the present article:—

EXISTING LINES.

	Miles.
Netherlands South African Railway Co.:	
Eastern Line, Pretoria—Komati Poort	295
Barberton branch, Kaapmuiden—Barberton	35
Southern Line, Pretoria—Elandsfontein	37
do. Elandsfontein—Johannesburg	10
do. Elandsfontein—Elsburg	4½
do. Elsburg—vaal River	36½
Rand Tram, Springs—Elandsfontein	21
South Western Line, Johannesburg—Klerksdorp	117
South Eastern Line, Elsburg—Natal Frontier	160
Pretoria Pietersburg Rwy. Co.:	
Main line, Pretoria—Pietersburg	178
	894
Selati Railway, Komati Poort—(Useless at present.)	71

NEW LINES PROJECTED.

In construction:	
Imperial Military, Vereeniging—Johannesburg	34*
Concessions granted by late Govt. S. A. R.:	
Private Co., Machadodorp—Ermelo	65
do. do. Lydenburg	70
Late S. A. R. Govt.:	
Vryheid—Buffalo River† (State line under construction)	39
Klerksdorp—Fourteen Streams‡	150
Southern Reef-line (Johannesburg)	20/25
Pretoria—Rustenburg	65
Rustenburg—Mafeking	155
Present terminus Selati Ry.—Pilgrim's Rest	(?)30
Springs—Balmoral	55
Pietersburg—Leydsdorp	45
Ermelo—Junction with line to Natal	65
Approximate total projected lines	795½

* Approximate cost £7,000 per mile.
† To join Dundee Branch Natal
‡ Forming direct route Johannesburg to Cape Town and western province.

Without surveys and estimates it is possible to do no more than guess at construction costs. But as an average it would be fair to take

the cost at £8,000 per mile. And if the cost of superintendence and labour is coming down, there is no reason why that figure should not be made to include equipment on a moderate scale. On this basis all the lines scheduled above would involve an eventual capital outlay of £6,360,000. But if we divide lines of primary necessity from those of secondary importance, we have a total of 445½ miles in the former class. The smaller scheme on the same basis would figure out at £3,560,000. For this sum would be completed the four lines already surveyed and sanctioned by the late government, viz., the Lydenburg, Ermelo, Vryheid and Rustenburg lines; the Vereeniging-Johannesburg line in construction; and the two immediate necessities, the Klerksdorp-Fourteen Streams and the Johannesburg South Reef line.

The finance of the scheme may be thus recapitulated:—

For buying up the Netherlands Railway,* say	£8,000,000
" " the Pretoria-Pietersburg Railway, say	1,500,000
" " the Selati line (+70)	?
895 miles (+70) for	£9,500,000
Cost of construction 445½ miles new lines, say*	3,560,000
Total cost old and new lines *minor* scheme 1,340½ miles (+70)	£13,060,000
Cost of acquiring existing lines as above	£9,500,000
Cost of construction 795½ miles new lines, say	6,360,000
Total cost old and new lines, *major* scheme, 1,690½ miles (+70)	£15,860,000

Briefly, for the sum of thirteen and a half millions the new colony could own about 1,400 miles of railway opening up the country in a fairly satisfactory manner. For three millions more a system of nearly 1,800 miles could be provided for, opening up adequately the mineral and agricultural resources of the country. The total area of the Transvaal has been estimated at 119,200 square miles. At the end of 1899 the Cape government system of railways had a total open mileage of 1,990 miles, the capital cost of which had been close upon £21,000,000. The area of the colony is 276,567 square miles. Private lines additional to those owned by the government bring the total railway mileage up to about 2,500. Natal owns 518 miles of line, of which the capital cost including equipment has been £7,694,118. The area of the "Garden Colony" irrespective of Zululand and Amatongaland is 20,851 square miles. It will be seen that the projected larger scheme would give to the Transvaal Colony one mile of track to every 66¼ square miles of territory. In the Cape Colony the existing relation is one to 110½ and in Natal one to 40¼. In both these colonies large extensions are in progress.

* The report of the Concessions Committee points to a figure considerably less, but the actual amount has yet to be determined.

MONEY-MAKING MANAGEMENT FOR WORKSHOP AND FACTORY.

By Charles U. Carpenter.

IV.—THE STOCK DEPARTMENT AND ITS SYSTEMS.

Mr. Carpenter's articles began in THE ENGINEERING MAGAZINE for February, 1902. In his first and second papers he dealt with the general principles of factory organisation, and with a concrete description of a highly successful example. His third paper discussed the departmentalising of the works, and the organisation of "systems" for dealing systematically with every phase of factory operations. He now takes up those systems in detail, beginning with stock and stock tracing. The next article will deal with costs. It will be interesting in this connection to consult Mr. Falconer's articles in this number and the preceding issue of the Magazine.—THE EDITORS.

THE importance of an accurate system for handling and tracing stock can be realized when consideration is given to its proper functions. The system in stock ordering should provide such checks as to prevent the possibility of the factory being delayed by reason of the non-receipt of stock either from outside manufacturers or from its own producing departments. The placing of orders in the factory should be so regulated as to enable the entire factory force to work to the best advantage at all times and at the same time keep down all unnecessary investment in stock and machinery. The stock keeping should provide a perpetual and accurate inventory and place a check on the use of stock by assemblers as well. This latter, together with the system of scrappage to be described later, will prevent the waste of stock through carelessness of the workmen, or the desire to conceal errors. This waste amounts to a surprisingly large sum in most establishments. The subject of stock tracing is of such importance that I deem it worthy of distinct and separate consideration. It is a part, not only of the stock system, but of the piecework and inspection systems, as well.

Different phases of stock. At least two different conditions must be met by any stock system that is designed to be at all universal in its application. In the manufacture of such articles as bicycles, sewing machines, and cash registers, it is necessary to make very quick deliveries. The product being somewhat standardized, it is possible and indeed necessary to carry in the stock rooms large quantities of finished product ready for the market, and also finished parts upon which the assembling rooms can draw at will to fill various orders.

Under such conditions the management, together with the stock department, can determine how many days supply of stock should be carried in the bins. Then, with these data, the stock department can place the orders in the factory regularly, giving due consideration to the length of time required to get stock through the factory and into the finished stock room.

This, however, is not possible in the manufacture of large pumps, engines, generators, etc. In such cases delivery is not and generally can not be made quickly and the parts must come through on "special orders." Naturally, it is of great importance that, under such conditions, the parts be put through the factory in the shortest possible time owing to the large investment tied up in the work. The systems given will, with slight changes, take care of both situations equally well. Consideration will first be given to the handling of large amounts of stock which can be carried in stock rooms in a finished condition, as far as machining is concerned, ready to be assembled into the finished product.

Stock rooms. These should be well-lighted and dry. It is a great mistake to neglect the location of the stock rooms, as large values are there represented which deserve close attention. They should be located with special view to ease of handling and transportation.

Storing stock. All stock, wherever possible, should be stored in well-built bins, properly numbered. If it is impossible to store it in the bins, a special place for each kind of stock must be set aside and no other kind of stock should ever be put there.

Calculating amounts of stock by count and weight. All stock received or delivered by the stock keepers must be weighed or counted to provide for the accuracy of the records and to prevent excessive deliveries. To facilitate this work a pair of "counting scales" can be used to good advantage. Computing large amounts of stock for checking up piece-work tickets, or for stock calculation, can be done with the aid of such scales in one-fifth of the time required by the ordinary methods. They are also very accurate.

Boxes. All stock, wherever possible, should be carried in substantial boxes. The boxes should be numbered on both ends and have a tin pocket attached for the stock-tracing card which will be described later.

Trucks. Substantial four-wheel trucks with ball bearings are very effective adjuncts in the transportation of stock on factory floors. A regular trucking force can be organized from which very good results can be secured. All stock carrying should be done by such an

organized set of men, taking this work entirely out of the hands of the several departments.

Information necessary for placing orders. Proper, definite and full data regarding the nature of, and specifications for, all stock, are necessary for the stock department before orders can be placed with outside manufacturers, or in the factory. This is also necessary in order that the factory force may work intelligently and with a minimum of errors.

The important specifications for new stock should be given by those most familiar with the new product. This must invariably be in writing and should be prepared by the designer or inventor, together with the head of the tool room. The following data should be given for each part:

I. Name of piece, or number. It is important that this be uniform throughout the factory.

II. Full specifications of raw stock to be used.

III. Wherever possible, the dimensions of finished parts.

IV. Full list of mechanical operations through which the stock should go, and all drawing numbers.

V. All pattern numbers.

VI. Full list of all tools and gauges to be used.

VII. List of most important points to be watched in machining and gauging, with the proper limits to be observed.

VIII. The number of parts of this particular stock used to each machine.

Copies of this should be sent to all foremen who handle the stock in any way so they may thoroughly familiarize themselves with the requirements. Often, they will submit suggestions involving important changes that result in great economy and a better product.

The stock department upon receipt of such reports will have all necessary information to enable them to place orders with manufacturers, or with the factory.

Stock system. Three rules must be rigidly observed before the success of any stock system is assured. First, a requisition (form to be described later) must be presented before stock is delivered to any one; Second, only the stock clerk or stock tracer should have authority to give or deliver stock to any one; Third, stock must be secured from stock room only, except when urgently needed, and then the stock tracer alone should secure the stock from the machining departments. Indiscriminate "helping one's self" *must be prohibited.*

The natural divisions of the stock system are as follows:—

I. Stock ordering.
II. Stock keeping.
III. Stock tracing.

These three divisions are sub-divided as follows:—

I. Stock ordering:—

a. From the outside manufacturer.
b. Into the factory for machining, or the production of parts.
c. To the assembling rooms for partial or final assembling of the product.

II. Stock keeping:—

a. Providing check on stock received from outside manufacturers to certify to bills.
b. Storing and keeping of raw stock, finished parts (not assembled) and assembled stock, and providing a perpetual inventory for each.
c. Supplying check on assemblers for stock used.

III. Stock tracing:—

a. Directing the machining of stock so as to keep all machinery operating as much of the time as possible and to prevent delays to assemblers.
b. Tabulating records, giving history of each lot of stock and providing data whereby its location in the factory can be shown immediately.
c. Directing the transportation of stock in the factory.

By applying the foregoing sub-divisions to actual practice, we find their natural order to be as follows:—

First—Stock is ordered from outside manufacturers.

Second—Stock is received from outside and checked as to quantity and quality.

Third—This stock is stored in stock rooms and a perpetual invoice is kept.

Fourth—Factory is ordered to manufacture certain parts from this raw stock.

Fifth—The stock is traced in its course through the factory of machining and inspecting.

Sixth—The finished parts are received and stored in the stock rooms and perpetual inventory provided.

Seventh—Assembling rooms are ordered to assemble the parts.

Eighth—A final positive check is kept on the assemblers.

Records. The life of any system lies in the nature of the records that are used; these should be as few in number as possible. Careful examination of the records given will show that they are very simple and contain only such information as the order clerk of the stock department should always have on hand. These records are but three in number. First, the Raw-Stock Order Record; second, the Finished-Stock Order Record; third, the Stock-Tracing and Cost Sheet. These should be upon substantial cards, there being one record for each kind of stock, and should be filed in a card index according to their number or name. It is of course necessary that such records contain very full and explicit information concerning the stock. The order record, in particular, should have full data concerning all orders, together with the correct inventory of the amount of stock on hand at all times. They must also provide some means whereby the order clerk, or the stock department, is automatically notified when the stock in any bin is down so low as to presage a dangerous shortage. This is done by establishing certain limits at which the stock in the bins should stand at all times. When the quantity of stock in the bins reaches this point, it indicates the condition of this stock to be dangerous and an investigation of the records must be made to determine whether or not more orders must be placed, or the orders already placed, rushed. This limit may be termed the "order limit." A further limit termed the "rush limit" may be used to indicate a specially dangerous condition and that especial attention must be given to *rush* it to avoid delays. This rush limit should be about one-half the quantity of the order limit, and it indicates that the quantity of the stock is in very bad condition. The quantity of stock designated as the order limit depends upon the number of parts required per machine and the time required to get it through the machine rooms.

The other forms used are largely to simplify the system and reduce the chances of error to a minimum. They are the foremen's order for the production of parts, the stock-tracing card, which gives a full description of every necessary operation, and the requisition for stock.

The first record to consider is the raw-stock order record. The form of such an order, designed as an index filing card, is shown on the next page.

Page_____ RAW STOCK ORDER RECORD.

Specifications_____

Name of Mfr._____ Am't used per Mo._____

Pattern No._____ Drawing No _____ Bin No _____

Order Limit_____ Where used _____

Rush Limit_____

Date	Ordered	Receiv'd	Ord'r'd in Factory		Delivered	Inventory	Order Limit Reference	Check No.
			Quantity	Purpose				

Note carefully the different items: full specifications, name of manufacturer, pattern number, drawing number, bin number, what parts are manufactured from it, order and rush limits, and amounts used per month. These are general data, information concerning which the stock department or order clerk should have at hand always. The order clerk secures this information from the written notification. The words at the head of each column describe the functions of the column clearly. The dates of all transactions are placed in the date column. The order and received columns give data regarding orders for raw stock, either from the foundry belonging to the firm, or from outside manufacturers, and the amounts received. Next is the divided column for orders placed in the factory for finished parts. The two sub-columns, quantity and purpose, are self-explanatory. In the purpose column may be placed the number of the piece ordered, if the stock is numbered instead of named, or the page and line number of the finished-stock order record. The delivered and inventory columns need no explanation. The check number indicates at all times the stock keeper who received and delivered stock. The order-limit reference column is used simply for the convenience of the order clerk.

Owing to the fact that foremen can seldom begin work on stock as soon as ordered, the stock for such undelivered orders, though still in the bins, should be deducted from the amount on hand (as shown by the inventory column) for the purpose of comparison with the order limit. It is clear that this is necessary, as otherwise several calls

for undelivered stock may be made at any time and the amount in the bins reduced to a very dangerous condition before additional orders are placed.

The order clerk is notified in writing by the stock keeper of all receipts and deliveries of stock; he is thus in a position to fill out the different columns as indicated. He must make it an invariable rule to complete the entire record as soon as such data come from the stock keeper and then compare the amount in the order-limit reference column with the amount of the order limit, as indicated at the top of the card. Thus it can be immediately determined whether additional orders should be placed anywhere, or unfilled orders should be rushed. Further, by comparing the amounts in the inventory column with that in the order-limit reference column it can be seen immediately if any of the foremen have an unusual number of orders for stock on which they have not started work.

Methods of placing orders in the factory, with the foremen, for the manufacture of parts and of giving the stock-tracing department the necessary information regarding them:—The three forms necessary for this part of the system are the ones mentioned before, viz: the foreman's order (in duplicate) for the production of parts, the stock-tracing card, and the stock-tracing and cost sheet, which should contain practically the same information. The original of the foreman's order, properly filled out, is sent to the foreman, the duplicate together with the stock-tracing card is sent to the raw-stock keeper, while the stock-tracing and cost sheet is sent to the stock tracer. These forms will serve as a check for accuracy upon both foremen and stock keepers, and when returned to the order clerk will furnish him all the information necessary to fill out his records. They will also serve as a notification to the stock tracer of the nature and date of all orders and also the date when the raw stock required to fill these orders is finally delivered to the foremen.

Foremen's order for the production of parts:—The proper time for placing orders with the foremen is determined from the finished-stock order record (a form to be described later) in precisely the same manner as is done in the case of raw stock from the raw-stock records. As stated above, these foremen's orders should be in duplicate. They should contain name of part ordered, number of pieces wanted, full specifications and quantity of raw stock needed together with pattern numbers, a list of the machining operations together with the drawing numbers, the number of the raw-stock record, and rush notices and the signature of the order clerk.

As previously stated, the original is sent to the foremen and the duplicate together with the stock-tracing card is sent to the raw-stock keeper. The stock keeper, as soon as he receives the duplicate, examines the condition of his stock, which serves as a safeguard against errors. When the foreman is ready to begin work he signs the original order and sends it to the stock keeper. Wherever possible, the stock keeper secures the necessary boxes for the stock, puts the box numbers on the original and duplicate of the foreman's order and the stock-tracing card. After signing the original and duplicate, he sends the former to the order clerk and the latter to the stock tracer. The order clerk then has the necessary information to enable him to make the proper entries on the raw-stock order record. The stock tracer is thus notified of the delivery of raw stock to the foreman and, after entering the proper box numbers and date of delivery on the stock-tracing and cost sheet, sends this duplicate to the foreman, who retains this as his record. By following this closely it will be seen that there is a perfect check on all parties concerned.

Stock-tracing card:—The stock-tracing card is deserving of close attention, owing to its close connection with the entire system described and to its possibilities even with other systems. In this system every box of stock is accompanied with its own stock-tracing card. Even where it is impossible to handle the stock in boxes, the card can still be used to great advantage.

STOCK-TRACING CARD

Box No _____ Date _____

Name _____

Am't Ordered _____ Order No. _____

Operations	Drawing Numbers	Amount Delivered	Time Del'd	Due Date	Inspector	Amount Lost	Amount Sent Ahead
I							
II							
III							
IV							

This card should contain box number, date of order, name of stock, quantity ordered and order number. In the main body of

the card should appear a full list of the mechanical operations, the drawing numbers necessary, number of pieces delivered from one operation to another, time delivered, due date, name of inspector, number of pieces lost, and quantity of stock sent ahead of the main order. At the bottom of the card is the place for the receipt of the stock keeper. Its value, both for reference and as a record, is apparent.

The objection is sometimes made by the inexperienced that these cards will be lost in going through a large factory. This depends entirely upon the manner in which the mattter is handled. Make the rule that the last department handling a card is responsible for it; that no man can get his time ticket o. k.'d for payment until the stock-tracing card is produced; that every foreman is responsible for all stock and cards in his department. If these rules are carried out the foremen will not receive stock unless it is accompanied by a card. Rules can also be made effective to keep the cards reasonably clean. In one factory, connected with the writer's experience, there are handled yearly over one hundred thousand of these cards, calling for many million pieces of stock, and the number of cards lost per year will not be over 100, a number so small as to be inappreciable. Even when lost the stock-tracing and cost sheet will supply all information necessary to make out a duplicate.

Stock-tracing and cost sheet:—This sheet will be fully shown under the description of the stock-tracing system. Its importance can be appreciated from the statement that upon it depend all records as to time consumed, costs, and location of stock. This record is filled out by the stock tracer. Upon the delivery of the stock (when finished) called for on this record to the stock room, the sheet is sent with the stock, is receipted by the stock keeper and then sent to the order clerk of the stock department. This furnishes the order clerk all necessary information regarding the delivery of stock to the stock rooms.

Finished-stock order record:—The only record needed to complete the system is that which is designed for the ordering and keeping of finished stock. This is developed along precisely the same lines as the raw-stock order record. However, in the case of finished stock, the deliveries to the assemblers are generally in much smaller quantities and much more numerous than those of raw stock. Consequently, it is usually well to put the inventory record upon a separate card, called the bin invoice card, and attach this to the regular order record. A form for the index card adapted to this record is shown on the following page.

Page_____ FINISHED-STOCK ORDER RECORD

Name of Part_____ Raw St'k page_____

Specifications of Raw Stock_____Amt. per 1000 parts

Operations											
Drawing Nos											

Order Limit Rush Limit Am't per Mo.

Ordered		Del'd to Factory		Received in Finished Stock Room					
Date	Amount	Date	Amount	Date	Amount	Date	Amount	Date	Amount

This record should be in card form, each card being properly numbered. It should contain name of stock, specifications of raw material and raw-stock record page, list of operations and list of drawings, where used, bin number, amount used per month, amount per order, amount of raw stock per 1,000 parts, order and rush limits. These important data are secured as shown on page 197. In the body of the record should appear the quantity of stock ordered and delivered to the foremen, together with the dates; also, the quantities of stock received in the stock room, together with the dates.

To complete the finished-stock order record, the entries for finished stock received in the stock rooms must be made. These data are secured, as stated before, from the stock-tracing and cost sheets which are sent to the stock keeper with the stock, receipted by him and in turn sent to the order clerk in the stock department. The order clerk, by comparison of dates, can readily tell to what order these receipts should apply and give credit to the proper order. He thus is always informed as to the exact condition and dates of outstanding orders.

Invoice card:—The invoice card should be attached to the finished-stock order record, as stated above. This card should contain:—name of stock, where used, order limit, rush limit, page number, bin number. The body of the card should show all receipts and deliveries of stock by the stock keeper together with the date, check number and inventory.

Page No _____ BIN INVOICE CARD

Name _____

Page (Raw Stock) _____ Bin No _____

Order Limit _____ Where _____

Rush Limit _____ used _____

Date	Received	Delivered	Inventory	Chk. No.	

The manner in which the order clerk is notified of all receipts of stock has been fully described.

Delivery of stock to the assembling rooms is made only on requisition on the stock keeper. This requisition is then countersigned by the stock keeper and sent to the order clerk, who secures from it all necessary information as to the delivery of stock. He then makes his inventory and compares it with the limits, and if the quantity of stock proves to be near the danger point, he examines the attached record and easily determines what action is necessary. Either more orders may have to be placed, or the stock tracer notified to rush this particular stock.

Requisition:—The requisition referred to is simple in form. It should contain the name of stock, quantity desired, for what used, and space for signature of foreman and stock keeper.

In some factories it is considered advisable to have the inventory of the stock carried at the stock bins. This can be effected by having the stock keeper keep a duplicate of the invoice card at each bin and make the proper entries on them for receipts, deliveries, and inventories. This, however, means a duplication of records. The plan of keeping the invoice card at the bin and the order records in the office, is frequently adopted. In this latter case the stock keeper alone must be depended upon to make the proper entries and comparisons with the order and rush limits. He must then report to the order clerk the condition of the stock when it reaches this stage. In the large factory referred to, this last plan is the one adopted, owing to the large number of different kinds of stock carried and the many receipts and

deliveries of stock made during the day. This requires but little time on the part of the stock keeper.

System for ordering and carrying in stock partially assembled parts:—It is often found very advantageous to assemble and carry in stock certain parts of a machine which are of particular intricacy. An explanation of this part of the system is not at all necessary, as the records and forms would be developed along practically the same lines as those already described. The orders in such cases would be sent to the assembling rooms.

Ordering the final finished product:—This is a comparatively simple matter. When the orders come in they must, of course, be recorded in the office. They can then be transmitted to the assembling rooms either directly or, better, through the stock department, so that any special features may be noted and stock correspondingly ordered. The stock department can then send the orders direct to the assembling rooms and the assembling rooms secure their finished parts for assembling from the stock room by requisition.

In the case of large work which requires special orders and the securing of special raw stock, the orders should invariably go through the stock department before going into the factory. Much trouble will also be avoided if the details of the finished product are carefully compared with the original signed order before shipment is made, to insure that no errors have been made and that the product is exactly as ordered.

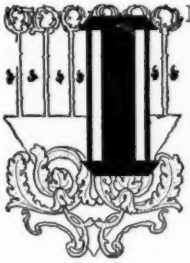
Number of men needed and costs of system:—The three great factors in favor of this system are, first, the absolute check on all stock at all times; second, the avoidance of expensive delays by compelling the placing of orders for stock at the proper time; third, the small expense of carrying out the system. The first two points have been fully covered. The last can best be answered by citing a case from experience. In the one referred to there are issued each year about one hundred thousand orders for stock, aggregating many millions of pieces. Over nineteen thousand orders and thirteen thousand kinds of stock must be watched constantly. This large amount of work is handled by one assistant head of the stock and cost department and seven clerks. The work of keeping up the records is so simple that high-priced men are not at all necessary. In most establishments one or, at the most, two clerks are all that will be needed to insure the results stated.

THE GROWTH OF ECONOMY IN MARINE ENGINEERING.

By Walter M. McFarland.

III.—THE INTRODUCTION OF MULTIPLE-EXPANSION ENGINES.

The first of Mr. McFarland's most interesting articles in this series appeared in March, and dealt with the very early history of marine engineering, from the invention of the steamboat through the period of the simple engine—the age of Watt, Fulton, Haswell and Isherwood. His second paper took up the development of the compound engine with higher steam pressures, and the contributions of Elder, Loring, Emery, and Rankine. In this third review he traces the rapid rise of economy following the publication of their investigations and the appearance of the multi-expansion engine. A fourth article next month, discussing the very latest advances in marine steam economy, will conclude the study.—The Editors.



N the case of the triple-expansion engine, as in that of so many other improvements in machinery, the invention or first use preceded by a considerable period the general introduction of the type. In some comments upon an article about multiple expansion engines at the Engineering Congress in Chicago in the year 1893, Mr. James Howden, widely known for his work in connection with forced draft, stated that he had taken out a patent as far back as November, 1860, for a triple expansion engine using steam of 150- to 200-pounds pressure. He says that he thinks it quite possible that the idea may have occurred to some one else at an earlier date, but he was unable to find any record of it. It may be mentioned, in passing, that in 1880 a board of United States naval engineers tested the machinery of the yacht Anthracite, which had triple-expansion engines designed by Mr. Loftus Perkins. The first completely successful use of the triple-expansion engine, however, was in the case of the steamship Aberdeen, whose machinery was designed and built under the supervision of Dr. A. C. Kirk, of the firm of R. Napier & Sons of Glasgow, in 1881.

In the Aberdeen we have the distinct feature of the steam passing through three cylinders successively, thereby differing from the three-cylinder compound engine, in which, after passing through the high-pressure cylinder, the steam was admitted to the two low-pressure cylinders at the same time. The reason for the superiority of the triple-expansion engine is perfectly plain from the previous experience of the

advantage of the compound engine over the simple one. The Michigan experiments by Isherwood had shown that in a single cylinder, if expansion was carried beyond a very moderate amount, excessive liquefaction occurred. The compound engine enabled the number of expansions to be carried much further on account of the division between two stages, but in the later compound engines, where the cylinder ratio was as high as four and one-half to one, it was found that an expansion suitable to the high-pressure carried would have involved excessive liquefaction in the high-pressure cylinder. The triple-expansion engine divided the expansion into three stages, thus making the number of expansions in any one cylinder small and within the limits where liquefaction was not serious. The introduction of the triple-expansion engine was very rapid and there was no such opposition to it as had occurred with the compound engine. Practice and theory had come together, or possibly it would be more accurate to say that theory had come to take account of all the details of practice, so that there were none to claim that by simply carrying higher pressures and making the cylinder ratios greater, the compound could compete with the triple-expansion engine.

It is somewhat difficult to give figures having real value which will show the exact percentage of increased economy of one type of engine over the other. To do this would require an elaborate comparison of actual average performances extending over long periods, which are as a rule impossible to secure. If we take the best results in the simple engine as three pounds of coal per indicated horse-power hour, and in the compound two pounds per indicated horse-power hour, we would have an increased economy of 33 per cent. About the best result with triple-expansion engines is 1.5 pounds per indicated horse-power hour. which would represent 25 per cent. gain by the triple-expansion over the compound. As a matter of fact, however, simple engines in ordinary practice rarely got a horse power for as little as 3 pounds of coal, and very few compounds cost less than 2.5 pounds of coal per indicated horse-power while in ordinary average cruising it is probable that the triple-expansion engine gets a horse power for 1.8 to 2.0 pounds per hour.

The first use of triple-expansion engines for naval vessels was also by Dr. Kirk's firm in the case of the British cruisers Australia and Galatea. These vessels as originally specified were to have three-cylinder compound engines, but his experience with triple-expansion engines in merchant vessels led Dr. Kirk to offer to guarantee a somewhat greater horse power for the same weight if permitted to use

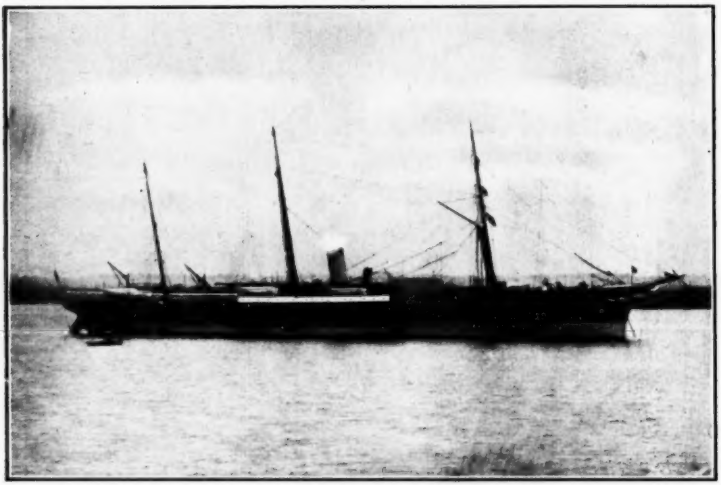
DR. ALEXANDER C. KIRK.

Designer of the first completely successful triple-expansion engine. By courtesy of Messrs. Wm. Beardmore & Co., successors to R. Napier & Sons, Ltd., with which firm Dr. Kirk was connected.

triple-expansion engines. Permission was granted to use engines of this type, and these two vessels made their steam trials in 1887 and were entirely successful. Since that date there has hardly been a war vessel designed anywhere which has not used triple-expansion engines.

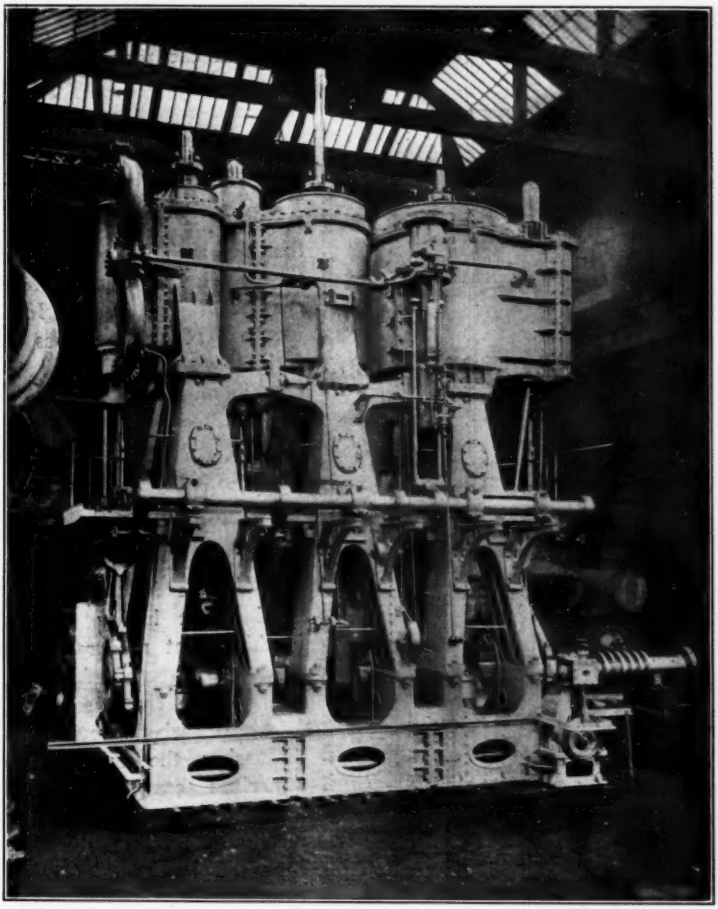
There has been a close relation between the development of the marine steam engine and the improvement in materials. Steam pressures

with the compound-engine were kept down for a time by the inability to procure boiler plates of sufficient dimensions, but the great improvement in the manufacture of open-hearth steel enabled the higher pressures, which were used at the end of the compound period, to be used safely. The Aberdeen used steam of about the same pressure as the last compound ships, namely, 125 pounds, but it was soon realized that if the full benefit of the triple-expansion principle was to be obtained, higher pressures should be used, and in a very short time they went to 150 and 160 pounds, the steel makers meeting the demand for the thick plates of the large dimensions which were necessary. Along with the increase in steam pressures and the gain in economy there had been progress along other lines, and the sizes and speeds of the ships had increased so that the machinery of the express steamers in the Trans-Atlantic service had become of very large size. For a time the larg-



THE STEAMSHIP ABERDEEN, MESSRS. GEO. THOMPSON & CO.'S ABERDEEN LINE.
Engined in 1881 by R. Napier & Sons, Glasgow, with the first successful triple-expansion marine engines. By courtesy of Messrs. Wm. Beardmore & Co.

est vessels with the most powerful engines afloat were the steamships Paris and New York of the American line and the Teutonic and Majestic of the White Star line, but these were eclipsed by the Campania and Lucania, which were not only larger vessels but had engines of 30,000 horse power. These vessels are 600 feet long, 65 feet 3 inches beam, and 25 feet mean draught, with a displacement of about 18,000 tons. The maximum horse power of their twin-screw engines is 31,-



TRIPLE-EXPANSION ENGINES OF 2,700 INDICATED HORSE POWER FOR THE STEAMSHIP ABERDEEN.

Built in 1881, by Messrs. R. Napier & Sons, now Messrs. Wm. Beardmore & Co., Glasgow, by whose courtesy we are enabled to present this photograph.

000, which on trial gave a speed of over 23 knots. Each engine has two high-pressure cylinders 37 inches in diameter, one intermediate 79 inches in diameter, and two low-pressures 98 inches in diameter, stroke 69 inches. There are twelve double-ended boilers and two single-ended, the double-ended boilers being 18 feet in diameter

MARINE-ENGINE TRIALS BY THE RESEARCH COMMITTEE OF INSTITUTION OF MECHANICAL ENGINEERS.

Name of vessel	Meteor 1888	Fusi Yama 1888	Colchester 1889	Tartar 1889	Iona 1889
Date of trial	Triple	Compound	Compound (twin)	Triple	Triple
Type of engines	29.4, 44, 70.1	27.3, 50.3	30, 57	26, 42, 69	22, 34, 57
Cylinder diameters, inches		33	36	42	39
Stroke, inches	47.9	55.59	86.5	70.0	61.1
Revolutions per minute	71.78	371.3	1979.7	1087.4	645.4
Aggregate indicated horse power	1994	2257	5820	5226	3160
Heating surface, square foot	6648	52	220	161	42
Grate surface, square foot	208	43.4	26.5	32.5	75.2
Ratio heating surface to grate surface	32.0	56.8	80.5	143.6	165.0
Steam pressure in boilers, pounds	145	18.98	26.1	11.93	22.4
Coal per hour per square foot grate surface	19.25	2.66	2.90	1.77	1.46
Coal per hour per indicated horse power	2.01	3.48	7.39	....	2.73
Feed water per square foot of heating surface per hour	4.49	7.06	7.49	....	9.15
Feed water per pound of coal	7.46	8.87	8.53	....	10.63
Feed water per pound of coal from and at 212° Fah	8.21	21.17	21.73	....	13.35
Feed water per indicated horse power per hour	14.98	0.27	0.20	0.27	0.31
Weight of machinery, including water per ind. horse power, ton	0.20	3.70	5.00	3.70	3.21
Indicated horse power per ton of machinery and water	5.00				

and 17 feet long with a working pressure of 165 pounds. Some of the plates in these boilers are 20 feet long, 7 feet wide, and 1.53 inches thick.

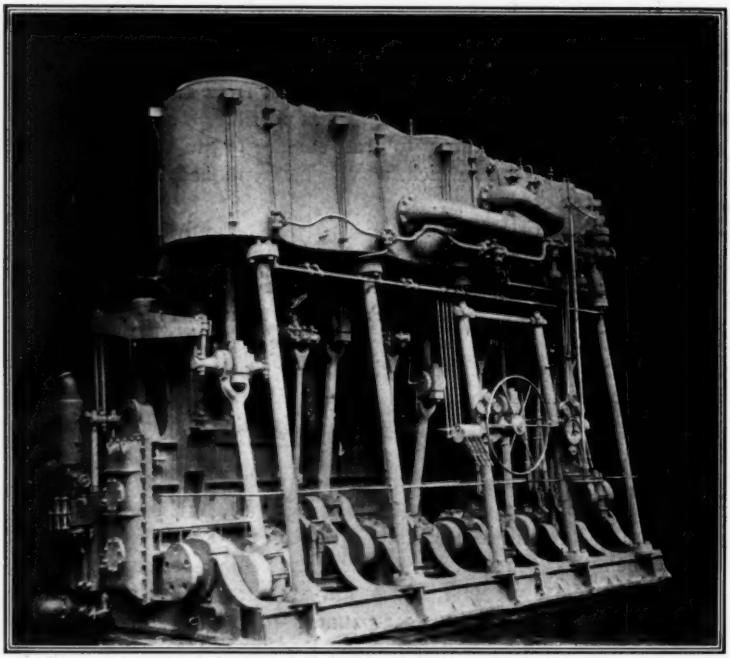
The most reliable data of the economy of triple-expansion engines come from the tests of the steamer Iona by the Research Committee of the British Institution of Mechanical Engineers. The Iona was one of a large class of freight steamers of the same tonnage and machinery which were built expressly for great economy. The machinery was designed by the Central Marine Engine Works at West Hartlepool, and is a remarkable example of what can be done in the way of turning out highly efficient machinery at moderate cost when modern manufacturing methods are employed. As I have remarked elsewhere in discussing the question of American competition with English manufacture, this machinery was at the very head of its class, for the reason that it was manufactured in thorough accord with modern methods. In the annexed table are given data of the trials of the Iona, as well as those of some other triple-expansion and compound engines, and it will be seen that a horse power was obtained

for 1.46 pounds of coal. The steam per horse power was also very low, being about 13.35 pounds per hour. The great economy in coal per horse power is due even more to the boilers than to the engines, as the evaporation per pound of coal from and at 212 degrees Fahrenheit was 10.63 pounds. This was possible on account of an unusually high ratio of heating to grate surface (75 to 1) and the use of moderate forced draft, which, as will be mentioned later, tends to a slight increase of economy.

The success of the triple-expansion engine and the possibility of carrying still higher pressures led to an early introduction of the quadruple-expansion engine, where the pressures went up to over 200 pounds. The St. Louis and St. Paul of the American line, built by the William Cramp & Son's Ship and Engine Building Co., have twin-screw quadruple-expansion engines carrying 210 pounds pressure. More recently the steamer Deutschland, with the largest engines actually afloat, also has quadruple-expansion engines. The Deutschland is 663 feet long, 67 feet beam, 28.5 feet draught and 23,200 tons displacement. She has twin-screw quadruple-expansion engines, each having two high-pressure and two low-pressure cylinders, with one first and one second intermediate cylinders, the cylinder diameters in inches being high-pressure, 36.6; first intermediate-pressure, 73.6; second intermediate pressure, 103.9; low-pressure, 106.3; piston stroke, 72.8, and the steam pressure 213 pounds.

While, as will be stated shortly, the greatest economy thus far known in marine engineering has been obtained with the quadruple-expansion engine, it should be stated that this type has not displaced the triple-expansion as the latter did the compound engine. So far from its being generally conceded that the quadruple-expansion engine is more economical, many designers believe, and carry out their belief, that the triple-expansion engine can be used with as great economy as the quadruple up to pressures of 250 pounds. Thus far no experiments have ever been made which attempted to measure the economy of the engines alone of the two types in large sizes, and, as will be noted presently in the case of the remarkably economical quadruple engine, there were so many other factors conducive to economy in the case of these particular ships, that the remarkable result in these cases cannot be regarded as definitely demonstrating that the quadruple engine at the pressures thus far carried is really more economical than the triple.

The vessels which at present have the record for the most economical machinery are the steamers Inchdune and Inchmarlo, whose machinery like that of the Iona, was built by the Central Marine Engine



FIVE-CRANK ENGINES AS FITTED ON BOARD THE STEAMERS INCHDUNE AND INCHMARLO. CENTRAL MARINE ENGINE WORKS, WEST HARTLEPOOL.

The vessels were built by Messrs. Wm. Gray & Co., Ltd., for Messrs. Hamilton Fraser & Co., of Liverpool. They are 360 by 48 by 29 feet, of 8,898 tons displacement. The engines have cylinders 17, 24, 34, 42 and 42 inches diameter by 42 inches stroke. Working pressure, 267 pounds per square inch. By courtesy of Wm. C. Borrowman, Esq're, General Manager of the Central Marine Engine Works.

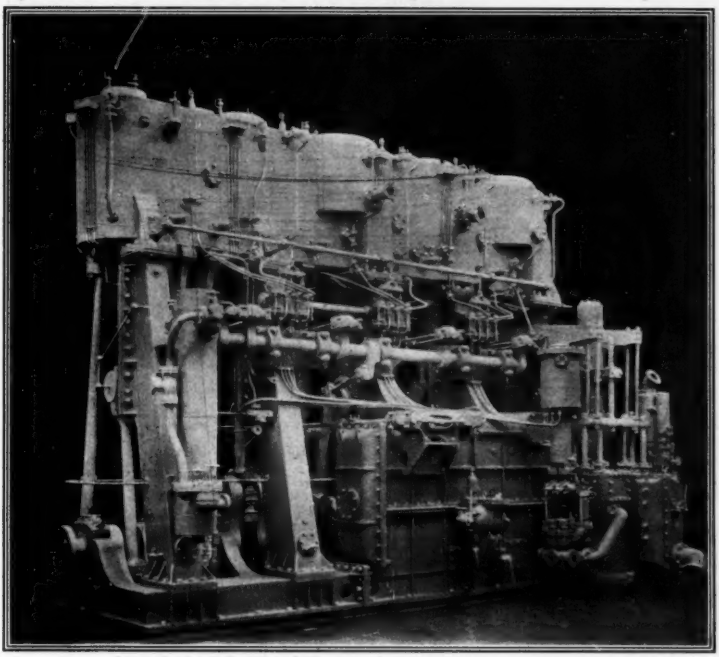
Co. of West Hartlepool. The engines are not of great size, the aggregate indicated horse power being only 1,600. The steam pressure carried is 267 pounds. There are five cylinders, two being low-pressures, but the expansion being in four stages. The cylinder diameters are 17, 24, 34, and 42 inches, the stroke of all pistons being 42 inches. The coal per horse-power on trial trip from Hartlepool to Dover was the unprecedentedly small amount of 0.97 pounds. In this machinery everything which would contribute to economy has been adopted. The steam is superheated to a temperature of about 500 degrees Fahrenheit, and all the cylinders, except the high-pressure, are jacketed both on the barrel and on the ends. The feed water is heated to a temperature of about 370 degrees and moderate forced draft of the induced type is

used, while the boilers are fitted with Serve tubes. The economy attained in this machinery of getting a horse-power for about one pound of coal is certainly remarkable, and it makes a record which it will be difficult for other designers to excel, if, indeed, in vessels of large power it can be reached.

It may be well here, as we have now given the most economical result which has been attained, to recapitulate the economy as expressed by the cost of a horse power in coal and water at different periods. It will be understood, of course, that the figures are simply close approximations and the years selected are for convenient periods.

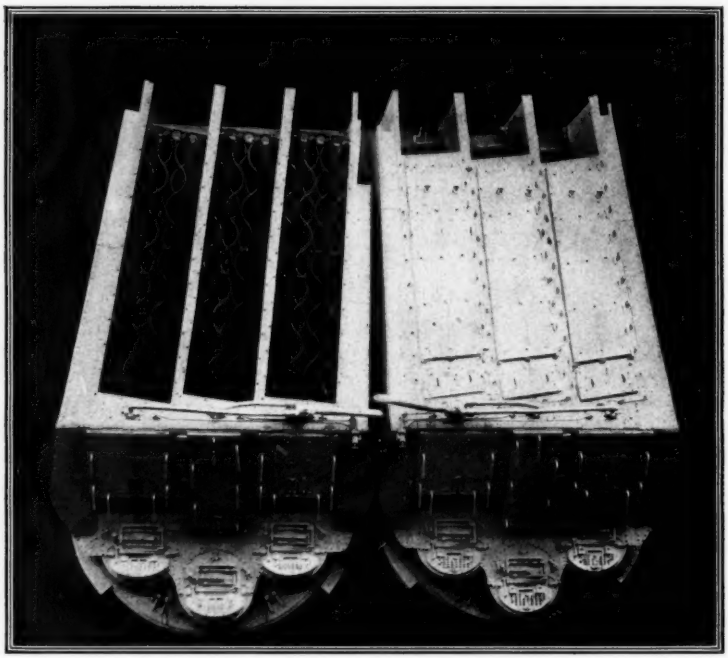
COST OF A HORSE POWER IN STEAM AND COAL.

	STEAM.	COAL.
1825	60 pounds	10.0 pounds
1850	40 pounds	5.9 pounds
1875	20 pounds	2.5 pounds
1900	11 pounds	1.0 pounds



REAR VIEW OF MUDD'S FIVE-CRANK ENGINES FOR THE INCHDUNE AND INCHMARLO.
By courtesy of Wm. C. Borrowman, Esq're, General Manager of the Central Marine Engine Works, West Hartlepool, builders of the engines.

We have thus far been considering almost entirely economy as measured by the coal expenditure per horse power, but, as we have previously remarked, economy in weight is also a most important feature, particularly in war vessels, as will be discussed under the next division. For the present it is interesting to discuss more fully the subject of forced draught; inasmuch as that has now become a standard feature with all the large highly powered merchant steamers, as



BOILERS OF THE INCHDUNE AND INCHMARLO.

Fitted with "Central" patent superheater and Ellis & Eaves system of induced draft. Working pressure, 267 pounds per square inch; guaranteed coal consumption, 1 pound per indicated horse power per hour. By courtesy of Wm. C. Borrowman, Esq're, General Manager Central Marine Engine Works.

well as war vessels. The reduced boiler weights to be secured by the use of forced draught appeal more strongly at first to the naval designer, who is always badly handicapped by weight limitations, and the earliest use upon an extended scale was in torpedo boats, where weights are cut down to the very lowest point. The method of applying forced draught, which has been used almost exclusively

in war vessels, is to enclose the whole fire room and blow in air under a moderate pressure, usually not exceeding about four to five inches of water in torpedo boats and not more than two inches in large naval vessels. In naval vessels, which are not only subdivided by water-tight bulkheads, but usually have a protective deck in addition, this is really the simplest method and requires few additional fittings. Experience had shown, even with natural draught, that the economy of evaporation fell off as the rate of combustion increased, and, as might have been expected this result was much more noticeable under forced draught. Two tables are given herewith, one showing a series of tests of a water tube boiler (Thornycroft) on the U. S. S. Cushing at rates of combustion from 7.5 to 66 pounds per square foot of grate, and the other

THORNYCROFT BOILER OF U. S. S. CUSHING ("SPEEDY" TYPE).

Air pressure in inches of water	*0.00	0.5	3.0	4.0
Steam pressure, pounds	250	250	250	250
Coal per hour per sq. ft. of grate	7.58	24.12	40.23	66.32
Evapn. (f. & a. 212°) per pound of coal	11.90	9.72	8.84	6.51
do. do. per sq. ft. of heating surface.	1.40	3.63	5.51	6.70
I. H. P. per 100 sq. ft. of H. S. on basis of 17 lbs. of steam (f. & a. 212°) per I. H. P	8.25	21.40	32.30	39.45
I. H. P. per ton of boiler and water on same basis	18.35	47.60	72.10	87.80

* Blowers discharging into open fire room.

EXPERIMENTS ON SHORE WITH A BABCOCK & WILCOX BOILER (MARINE TYPE) WITH AND WITHOUT HEATED DRAUGHT.

Heating surface, 1,950 sq. ft.; grate surface, 54.7 sq. ft.; H. S: G. S. 35 to 1. Trials, six hours each.

Kind of draught used		Hot	Hot	Hot	Cold	Cold
Boiler pressure, pounds		200	200	200	184	200
Feed temperature, Fahr.		110	110	110	110	110
Average air pressures in inches of water	Chimney	−0.48	−0.40	−0.27	−0.33	−0.42
	Flue	−0.22	−0.26	−0.26	−0.09	+0.07
	Furnace	+0.15	−0.04	−0.24	+0.08	+0.43
	Fire Room	+1.05	+0.70	0.00	+0.48	+1.03
	Ash Pit	+0.48	+0.30	−0.12	+0.48	+1.03
Temperatures, Fahr.	Air in Fire Room (entering heater)	91	83	161	99	91
	Air in Ash Pit (leaving heater)	290	273	311	99	91
	Gases in chimney by Pyrometer	657	545	488	...	...
Moisture in steam, per cent		0.43	0.65	0.58	0.49	0.57
Coal per hour per sq. ft. of grate, pounds		28.48	21.92	12.41	25.02	33.15
Refuse in coal, per cent		10.3	9.8	10.8	9.7	8.2
Water evaporated	Per pound of coal, actual conditions	8.22	8.56	9.40	8.02	7.62
	Per pound of coal, f. & a., 212°	9.55	9.94	10.93	9.30	8.54
	Per pound of combustible, f. & a. 212°	10.65	11.02	12.25	10.30	9.31
	Per sq. ft. of H. S. per hour, f. & a. 212°	7.63	6.12	3.81	6.53	8.24
	Per sq. ft. of G. S. per hour, f. & a. 212°	271.9	218.1	135.7	232.7	294.6

tests of a Babcock & Wilcox boiler, where there is not so great a variation in the combustion, but where the reduction in economy is still quite noticeable.

An interesting instance of history repeating itself is furnished by the estimates of the cost of power in naval vessels with triple-expansion engines and forced draught in the early days of the "new navy" of the United States. It was a repetition of what had occurred when the compound engine was introduced. The "fairy tales" of getting a

horse power at full power per 1.6 pounds of coal and at low power for as little as 1.2 pounds were believed by some naval men (not engineers) and official documents contained tables with these figures used in computing the "radii of action."

It is almost needless to say that Admiral Melville utterly discountenanced such figures, and as soon as he had an opportunity had the coal measured on several full-power trials under forced draught. This was the first time it had ever been done and the results were very different from the estimates,—about 2.6 pounds per indicated-horse-power hour instead of 1.6.

This was in 1890 and with closed fire rooms. Since that date, with more economical machinery, better results have been obtained, but in no case yet has as low a figure as 1.6 pounds per indicated horse-power hour been obtained for maximum power.

Besides the production of forced draught by a closed fire room, another method, which has been used to a slight extent in naval vessels and very largely in merchant vessels, is known as the "closed ash-pit system." Here the air under pressure is blown into a casing which surrounds the furnace and ash-pit. Mr. James Howden, who has done so much in developing this method of forced draught, provides for heating the air on its way to the ash-pit, and his system is used almost entirely on the large merchant steamers, where it has given great satisfaction, not only in the increase of power but in giving this increase with economy. It has been somewhat difficult to get exact figures of the cost of power in vessels with this system, as compared with similar vessels using other methods, but in 1897 some small gunboats in the United States navy offered a chance for comparison. Two twin-screw vessels were alike in other respects, except that one had cylindrical boilers fitted with Howden draught, while the other had water-tube boilers. The cost of power in the two cases was 1.72 pounds per indicated horse-power hour for the ship fitted with the Howden system and 2.18 pounds for the other, thus showing a decided economy for that system. The coal was the same in both cases, and of excellent quality.

Another system which has been used to some extent is known as "induced draught," where large fans placed near the base of the smoke pipe draw the heated gases through the boiler and discharge into the smoke pipe. This system is fitted to the steamers Inchdune and Inchmarlo, which have been mentioned above.

In the table given opposite, which is taken from an article published by Admiral Melville about two years ago, the weights of boil-

Name of vessel.	Date.	Weights in tons. All machy. and water.	Main and auxy. engines only.	Boilers and water.	Water in boilers.	I. H. P. per ton. All machinery.	Engines only.	Boilers and water.	Kind of boilers.
H. M. S. Warrior.....	1861	898.2	421.6	476.6	171.7	6.09	12.97	11.47	Box; horizontal fire-tube
U. S. S. Wamp.noag...	1865	1250	612.0	638.0	157.7	3.24	6.62	6.35	Box; vertical water-tube
H. M. S. Devastation..	1872	972	484.2	487.8	125.8	6.84	13.73	13.04	Box; horizontal fire-tube
U. S. S. Trenton.....	1876	976	497.0	479.0	121.5	2.47	4.86	5.04	Cylindrical; single-end
H. M. S. Inflexible....	1878	1366.4	654.2	712.2	187.4	6.21	12.96	11.9	Oval; single and double-end
*U. S. S. San Francisco	1888	914	433	481	125.5	10.63	22.44	20.2	Cylindrical; double-end
U. S. S. Minneapolis..	1891	1920	694	1226	331.7	10.87	30.06	17.0	" " "
U. S. S. Oregon.....	1892	1068.4	436.4	632.0	143.2	10.38	25.46	17.6	" " "
H. M. S. Prince George.	1896	1326.6	623.8	702.7	165.2	9.26	19.7	17.3	Cylindrical single-end
H. M. S. Terrible.....	1897	2224.8	1076.4	1148.3	48.7	11.53	23.8	22.3	Belleville water-tube
†U. S. S. Cushing.....	1889	54.5	24.5	30.0	3.5	32.29	71.8	58.7	Thornycroft water-tube
†H. M. S. Ferret.....	1894	123.6	59.4	64.1	11.5	36.30	75.2	69.7	Normand " "
†H. M. S. Janus.....	1895	120.0	49.0	70.7	7.9	31.58	77.3	53.6	Reed water-tube
†H. M. S. Desperate....	1896	128.0	61.5	66.5	7.7	45.30	94.3	87.2	Thornycroft water-tube
†H. M. S. Quail.....	1897	144.3	68.6	75.7	11.3	41.97	88.4	80.1	Normand " "
H. M. S. Diadem.....	1898	1436.7	688.3	748.4	39.0	12.01	25.1	23.1	Belleville " "
†U. S. S. Foote.....	1897	50.8	24.5	26.3	4.0	47.22	98.0	91.2	Mosher " "
†U. S. S. Farragut.....	1898	1.0.0	56.8	63.2	10.5	46.67	98.6	88.6	Thornycroft " "
†U. S. Destroyers.....	1898	189.1	89.8	99.3	15.9	42.30	89.1	80.6	" " "
†U. S. Torpedo Boats..	1898	79.7	35.5	43.8	6.6	37.62	84.5	68.6	" " "
H. M. Cressy.....	1898	1800	858.0	942.0	49.3	11.67	24.5	22.3	Belleville " "

*All after this date have forced draught.
†Torpedo vessel.

WEIGHTS AND CAPACITIES OF BOILERS AND ENGINES OF WAR VESSELS.

ers per horse power at different periods is shown, and by the dates it is easy to see the marked effect of forced draught in reducing the boiler weights.

A method of increasing the total economy which has been tried at intervals from the very earliest periods is the obvious one of heating the feed water. In land machinery, where the engines work non-condensing, the obvious method of accomplishing this is to heat the feed by means of the exhaust steam. This, of course, is inapplicable where the engines are condensing, although to a moderate extent where the auxiliaries are independent of the main engines this can be done. The method which in recent years has had the most

vogue is to heat the feed by live steam. At first sight this seems very much like the process of attempting to get rich by taking money from one pocket and putting it in the other, but the fact of an actual increase of economy has been demonstrated, and the explanation which is given by some of the best engineers who have investigated the subject is that the function of the boiler should be simply to impart the latent heat required to form steam from the water, the feed being supplied at about the temperature due to the steam pressure. Feed-water heaters of this type are being used to a considerable degree on the later steamers, and are included in the equipment of the Inchdune and Inchmarlo.

As already mentioned, in these steamers the steam is superheated. This is accomplished by passing it through superheaters placed in the uptakes of the boilers before the hot gases go through the air heaters for the forced draught. As was mentioned in an earlier article,* superheating has been tried at various times, and has always been abandoned after a certain amount of use, on account of the rapid deterioration of the superheaters. We understand corrosion and how to prevent it better now than in the past, and it seems probable that with intelligent care the superheaters can now be made to give a reasonable endurance. Economy due to this cause is undoubted.

In discussing economy on the side of weight of machinery a most important place must be given to a development of the last ten years in the introduction of water-tube boilers. There has been so much discussion of this subject in the technical press in the last few years that we need not go into the detail that would be appropriate in an article on this subject alone. It may be mentioned, however, that the earliest use in a practical way was in torpedo vessels, where the tubes were of small diameter and consequently quite thin, so that a large amount of heating surface and great boiler capacity could be provided on very little weight. Water-tube boilers with large tubes have, however, in the last decade become recognized as a necessity in war vessels. The table already referred to gives data on water-tube boilers of several types on different ships, so that the reduction in boiler weigths due to this type of boiler can be readily seen.

Water-tube boilers have not as yet been largely introduced in the merchant service, although some enterprising British owners have used the Babcock & Wilcox boiler and a number of steamers on the Great Lakes of North America also use this boiler. The Belleville boiler, which has been used so extensively in the British navy, has

* See THE ENGINEERING MAGAZINE, March, 1902, page 844.

also been used in the French navy and for a long time has given satisfactory service in the vessels of the Messageries Maritimes.

There has undoubtedly been a feeling among the designers of the machinery for merchant vessels that as the limit of pressure for shell boilers has apparently not yet been reached, (the Inchdune and Inchmarlo carrying 267 pounds have cylindrical boilers), and as the working of these boilers is so thoroughly understood by the engineering personnel who are in charge of them, there is not the same inducement to abandon their use for water-tube boilers as in the navy, where weight is of such great importance. The recent adverse criticism of the Belleville boiler in the British navy will probably tend to confirm this opinion, although I have long believed that the water-tube boiler is certain to supersede the shell boiler before many years.

Messrs. Normand and Sigaudy have proposed a modification of the small-tube boiler to adapt it for large naval vessels and merchant steamers by a slight increase in the diameter and a considerable increase in thickness, and to me it seems that this ought to remove one of the main objections to water-tube boilers, which has been the probability of early wearing out due to corrosion. As a matter of fact, the principal use of water-tube boilers has been in naval vessels, where the circumstances are such as to aggravate the natural rapidity of corrosion owing to the normal use of only a portion of the boiler power, the other boilers remaining idle. All experience has shown that a boiler will last much longer under constant use with reasonable care than when used intermittently. During the next decade there will be an opportunity to test thoroughly the longevity of water-tube boilers in naval vessels, and, if they prove satisfactory, it seems almost certain that shell boilers will be displaced in favor of the later type.

An adjunct to the boiler equipment of modern vessels which has some effect in increasing economy is the evaporator. Although the effect of scale on heating surfaces in reducing the evaporation was undoubtedly greatly exaggerated when it was a common feature, there can be no doubt it should never be allowed to be deposited in modern boilers with their high pressures and the high temperature of the metal. This, of course, means that nothing but fresh water should be fed into the boilers, and in vessels making long cruises where it is inconvenient to carry a reserve supply of fresh water the evaporator enables this to be done. The evaporator is really a small boiler in which the heat is supplied by steam of moderate pressure passing through the inside of a nest of tubes, the salt water being on the outside. There will be, of course, a great deposition of scale, but the

design of the evaporator anticipates this and provides for its ready removal by so arranging the nest of tubes that it can easily be taken out of the shell and the scale cracked off. These evaporators are sometimes made on the "multiple effect" principle so familiar in sugar boiling, the steam evaporated in the first effect going through the nest of tubes in the second effect. This will be mentioned again in connection with the distilling ships for naval fleets in the next article.

I have now traced in a general way the progress of economy from the first quarter of the last century, when the coal per horse power was ten pounds, down to the beginning of this century, when it has fallen to one pound, and have pointed out the steps which have contributed to secure this economy. The tremendous increase of speeds in war vessels in recent years and some of the peculiarities of the conditions obtaining in such vessels have not been mentioned thus far, as it would have interfered somewhat with the continuity of the general discussion. The consideration of the methods adopted in recent years to secure economy on naval vessels, together with a few other points bearing upon the subject of economy, both in fuel and weight, will form the last article in this series.

THE OPERATION OF THE MODERN GRAIN ELEVATOR.

By Day Allen Willey.

Mr. Willey's paper will be read with special interest as a sequel to Mr. G. H. Hull's notable article in our March number laying bare the mischievous and trouble-breeding fallacy of "over-production." A very few years ago we were hearing often of an "over-production" of wheat, or corn, or oats. But of late years we hear nothing of such an absurd and impossible occurrence. And this is obviously because transportation facilities and scientific systems of storage have rendered it both practicable and profitable to take care of any temporary surplus of the staples of agriculture. In like manner, scientific cold storage has made an "over-production" of fruit, or eggs, or butter, a thing of the past. The next long stride in the forward march of industrial progress will be accomplished when we prove to the producers of the great staples of the industrial world—coal, iron, steel, copper, tin, lead, and crude rubber—that they are talking nonsense when they talk or think of "over-production." Such a thing has never yet occurred—never can occur! These form the very basis of all manufacture, all wealth. They are non-perishable and can be stored at trifling cost as compared with agricultural produce. For these reasons Mr. Willey's paper supplies a timely and valuable object lesson to the producers of the raw materials of the industrial world.—THE EDITORS.

HE grain trade of the United States has been materially influenced within the last decade through the changes made in the method of transporting and storing the various cereals. The remarkable increase in the acreage devoted to such staples as wheat and corn in the great fields of the West has rendered the old-time method of storing on the premises obsolete. Provision must be made for an increase in a single season of, perhaps, three hundred million bushels of corn, alone, to say nothing of fifty or one hundred million bushels of wheat and the same quantity of oats, for it must be remembered that the farmers of the United States to-day are sowing corn fields aggregating over eighty million acres—ten million more than ten years ago—and harvesting two billion bushels and over in a season. Their wheat fields cover forty million acres—four million more than in 1890—and even the oats area is nearly thirty million acres, an increase of 20 per cent.

It may be impossible to sell such a crop immediately except at a loss. If sold by the farmer, the speculator or middle man may decide to hold it for an upward turn of the market, for the grain yield has now reached a point where in ordinary seasons it far exceeds the demand for domestic consumption and must be kept in bulk awaiting

the foreign outlook. Therefore the imperative necessity for storage facilities has resulted in the development of the elevator system in America on a scale unknown elsewhere in the world.

On a Dakota, Kansas, or Nebraska farm where the harvest field may cover 500 or 2,000 acres, only a small portion of the yield is threshed and placed in the barn bins. The bulk is carried to what are termed railroad elevators located in convenient towns. These vary in capacity from 10,000 to 100,00 bushels according to their location in the producing district, and from them the transportation company loads its cars for the domestic or foreign market. But the district elevators as they might be called, represent only a fraction of the space for storage which now exists in the United States. Before it is loaded on shipboard at tidewater, a cargo may pass through four or five different buildings, be transfererd from car to vessel and back again to car, as the modern processes employed facilitate its handling.

Elevators are divided into two classes, receiving houses and transfer houses. All of the first-named structures are located on shore, but at cities on the American Great Lakes and along the Atlantic seaboard can be found floating elevators by which the contents of the lighter or canal boat are discharged into the hold of the ship.

The transfer elevators are usually located at the water side, as they are intended for moving grain from vessel to car and vice versa. If they are marine elevators the plans provide for running the grain cars directly into the structure, track being laid along the ground floor of the building. If the location is such that this plan is impracticable, the track is laid along the side, and from openings in the buildings project the receiving legs or spouts, which are from 15 to 25 feet in length, hinged, so that they can be hoisted against the side of the building when not in use. The end of the spout is carried into the car by the feeder, who moves it from place to place as the contents of the car are emptied. With the spouts in modern use all of the grain with the exception of a few shovels full can be taken out so that the only manual labour required is that of the feeder. As an ordinary leg will elevate from 9,000 to 10,000 bushels an hour, a trainload of thirty or forty cars representing 1,500 tons can be passed into the building in this time if it have the average number of receiving spouts.

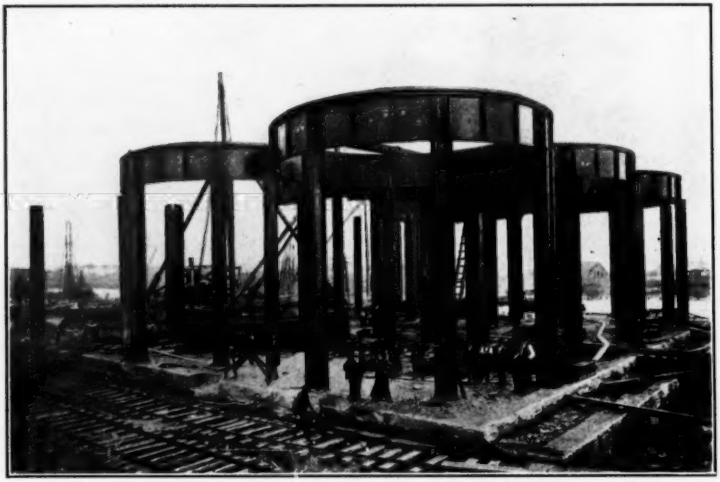
As in the storage elevator, the grain is conveyed to the top compartment, to be held until it flows into the cleaning hoppers, thence to the scales, thence to the distributing or marine legs. The latter are much larger than the receiving spouts, as one is allotted to serve a hatchway. They have an average capacity of from 20,000 to 25,000

SETTING MASONRY PEDESTALS FOR THE FOUNDATIONS OF A GREAT TANK-BIN ELEVATOR.

bushels an hour, and are of course adjustable, although the cargo must be properly trimmed by the stevedores. So rapidly does one of the elevators transfer its contents, that the first of a carload of wheat may be deposited in the hold of the vessel on the other side of the structure before the last bushel has left the car itself.

The storage elevators are divided into bins of various sizes, with a view of distributing the weight as evenly as possible upon the foundation of the building, and also equalising the side pressure on the walls. In the wooden structure the bins are square in shape, extending from the top to the ground floor, and are usually massed in the center of the building. As much of the machinery as possible is installed in the cupola, with the exception of the power plant which, in the steam-driven elevator, is generally located in a separate building as a precaution against fire and as a matter of convenience. The plan followed in the elevator construction of today is usually to locate the distributing department next to the bins, above it the scale room, above this the cleaning garners, the shafting and other transmitting machinery being placed at the top. In receiving grain the same method is employed as in the transfer elevator, the contents of

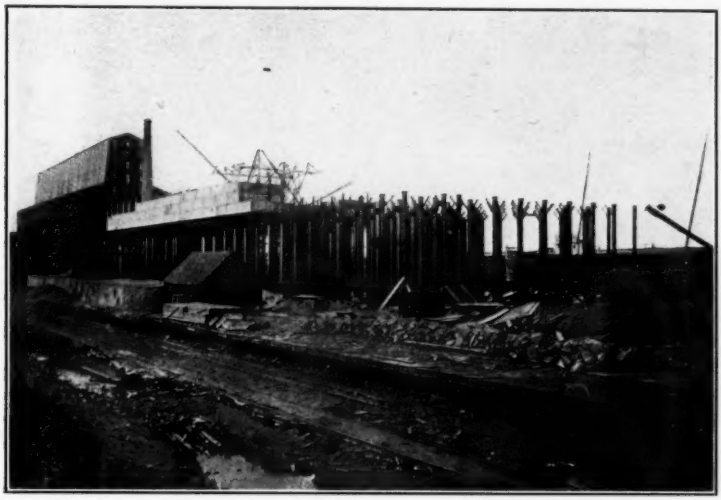
the car being carried to the top of the building. In this process and in transmission to the other compartments the systems employed include suction through wood or metal conduits to which are attached exhaust fans thus creating a partial vacuum, or the use of conveyers. The latter are generally composed of endless belts carrying buckets made of sheet metal which fill and discharge automatically as the belt



ERECTION OF STEEL FRAMEWORK FOR BIN TANKS.
Showing the concrete foundations on which they rest.

moves. The belts are used also for carrying away the screenings from the cleaning machinery. The dust and other fine particles are usually removed by an air current produced by a fan and conveyed outside of the building through special spouts. It may be said here that the transfer capacity of the machinery is so adjusted to the different departments in a modern elevator that it is not necessary to stop the machinery at any time to regulate the movement of the grain. The modern method of cleaning the grain is to pass it by belts or gravitation over rapidly moving sieves, which separate the foreign matter which may remain after the treatment. The weighing floor is provided with a series of bins and scales, each of which usually has a capacity of from 10,000 to 15,000 bushels. As fast as a bin is filled, the weight is registered automatically and a door in the bottom is released, allowing the grain to flow into the storage department or into one of the transfer spouts as desired. The house is provided with two sets of scales, so that while one portion of the grain is being

cleaned, weighed and stored, another portion may be loaded on shipboard or into the cars without interfering with the other process. During the entire operation the only manual labor needed in adjusting the spouts, and stopping and starting the machinery. Consequently a modern steam elevator, having a capacity for transferring 100,000 bushels of grain in an hour, can be operated by a force consisting of engineer and fireman, the spout tenders, and a half dozen hands to guard against possible accidents in the different departments. The trimming of the vessels is not considered a portion of the elevator work. In elevators where steam is the power directly applied, the main driving belt extends from the engine room to the machinery floor in the upper part of the building, turning a line shaft and pulleys belted to the fans and conveyors. In some of the recently constructed elevators electric motors are employed. These enable operation of one sec-

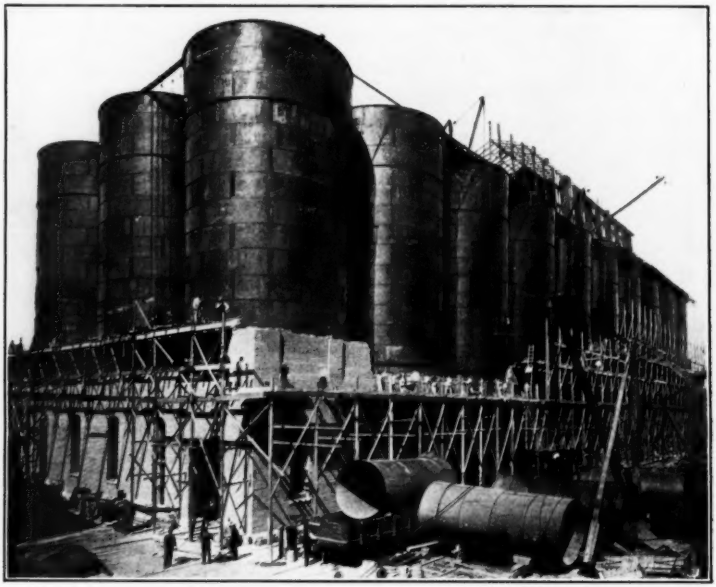


LAYING THE FOUNDATIONS AND SUPPORTING COLUMNS FOR THE LARGEST STEEL ELEVATOR IN THE WORLD.

tion of the apparatus if desired independently of the others. These motors are belted to the legs, fans, and conveyor pulley.

The tendency in modern storage house construction is to increase capacity. Ten years ago a million-bushel elevator was considered large; but the structures which have recently been erected a railway terminals and at important harbours range from 1,500,000 to 3,000,000 bushels storage capacity and some of them have facilities for load-

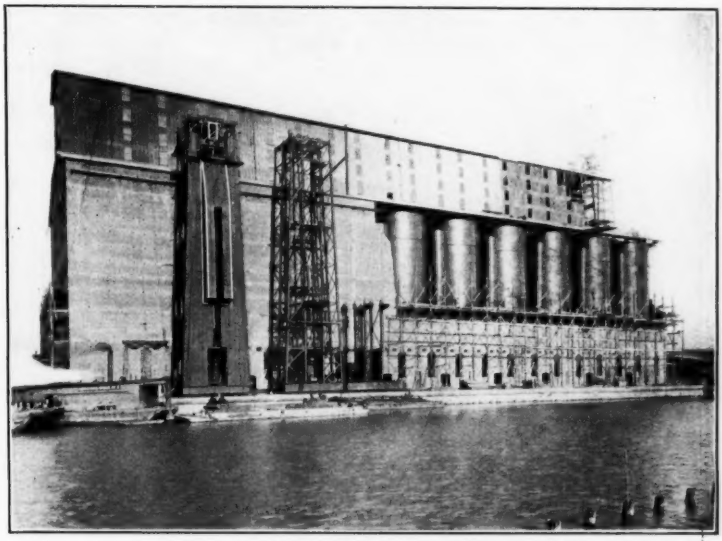
ing at one time three steamships, each of 7,000 tons carrying capacity. The great weight to be sustained by such structures and the progress made in the erection of steel buildings has caused steel to be employed with very satisfactory results in some of the elevators recently built on the Great Lakes. One of these elevators, reputed to be the largest storage house in the world, having a total capacity of 3,100,000 bushels, was erected by the Great Northern Railroad Company at its terminals at West Superior, Wis., and is used for handling corn, wheat and oats. As it represents the latest ideas in elevator construction, its principal features may be alluded to in this article.



SYSTEM OF TANK-ELEVATOR ARRANGEMENT AND CONSTRUCTION, SHOWING OUTER STRUCTURE OF BRICK.

The steel framework rests upon 280 columns of the same material, in turn supported upon concrete pedestals and piling. The outside walls of the lower portion consists of brick resting on stone foundation. The storage compartments are rectangular bins, each 85 feet in height and varying from 6,300 bushels to 24,900 bushels capacity. The bins are made of steel plates 5 feet in length and ranging from 5/16 to 3/16 of an inch in thickness. The arrangement of the floors is similar to that in the ordinary elevator, but in operation the cars

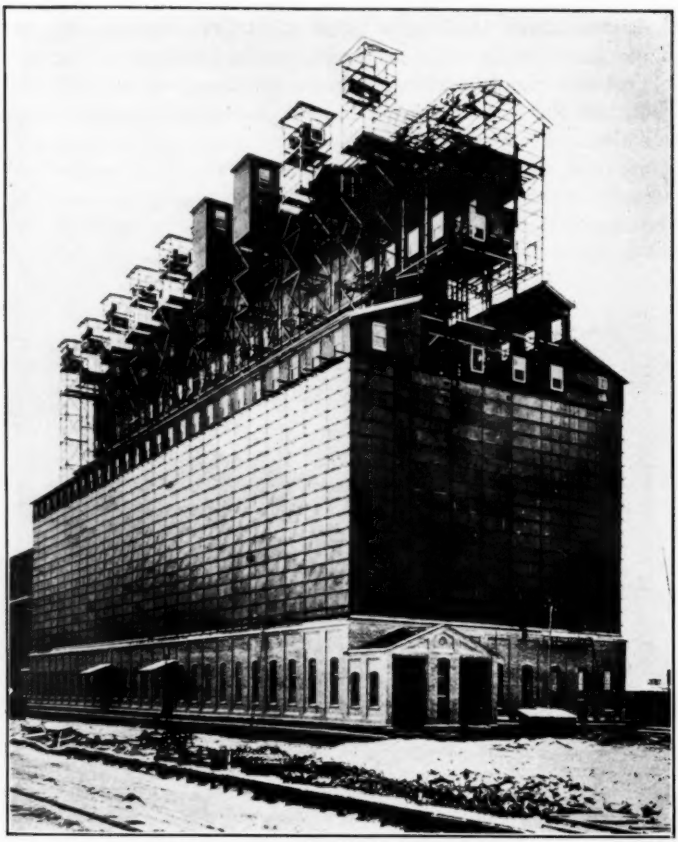
are hauled into the building in trains of nine each by a cable system. As the grain passes from the cars into the hoppers it is taken by endless-belt carriers from the hoppers to the top of the elevator, where it falls into the garners, thence into the scale hoppers, and thence to the scales. From these it drops through a swinging-turn-head into spouts, from which it is taken by a belt conveyor and handled longitudinally of the building and delivered into the proper bin. If it is to be cleaned it falls through the bin to one of the cleaning legs, which



ELEVATOR WITH OUTER BRICK WALL PARTLY COMPLETED.
This exhibits the arrangement of the tank bins and the steel framework of the elevator.

elevates it. Thence it passes over the sieves of the cleaning machines, returns again to the top of the house, and down into a bin. Before being sent to the shipping bins the grain is weighed a second time. A novel feature of the equipment is a system of automatic shovels, there being one for each car. Each set of nine shovels is so placed on a hanging track that a shovel can be "spouted" to any one of the cars. Each line of shovels is run by two sets of rope drives. Yard room is provided for 160 cars at one time and the empty cars can be quickly discharged by means of a transfer table to the 12 yard tracks which are provided.

In providing power for the various processes, the plan was followed of utilizing individual motors as much as possible in order to



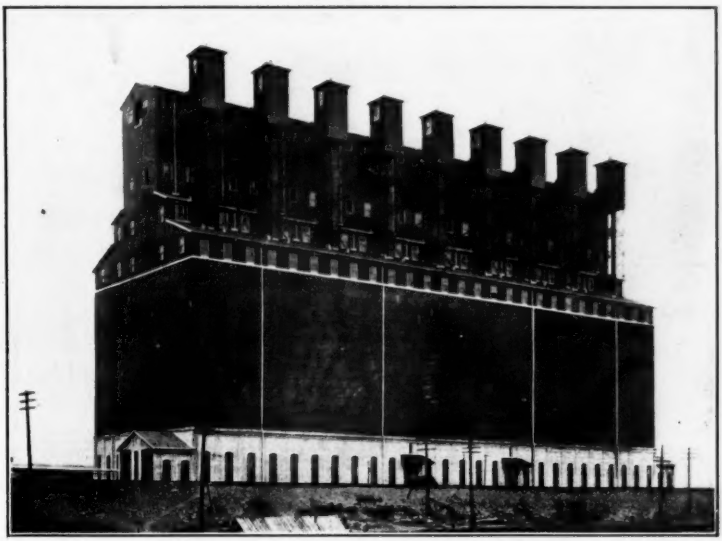
COMPLETING THE SUPERSTRUCTURE, SHOWING THE FRAMEWORK OF THE TOWER FOR HOISTING AND CONVEYING MACHINERY.

obtain greater economy in power distribution. Electricity is depended upon entirely, even the cable system for hauling cars into the building being operated by a 100-horse-power motor. Each conveying belt, cleaner leg, fan, and power shovel is operated by an individual motor ranging from 7½ to 100 horse power, requiring a total of 2,070 horse power. The elevator loads 300,000 bushels of grain in twenty-four hours on board vessels and unloads six hundred cars during the same period.

The storage facilities of several other lake ports have recently been increased by the building of elevators, which consist of a series of

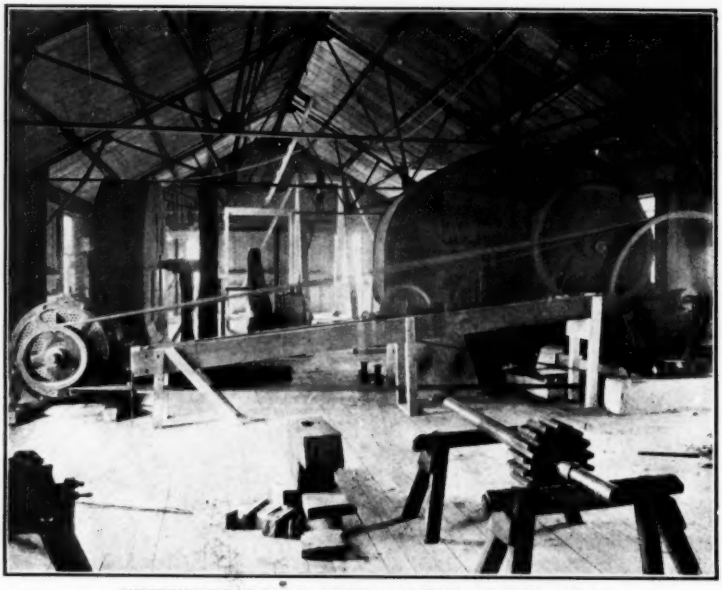
cylinders of boiler plate, each of which is separated into bins of requisite size. In some cases the cylinders are enclosed in a shell of brick, although several have been built at Buffalo and elsewhere without this casing. As in the structure at West Superior, the bulk of the machinery is located in a cupola above the bins. The grain is placed on shipboard either by the spout method, or by the conveyor system installed in wooden galleries extending from foundation to roof.

By the elaboration of the conveyor belt an elevator can be constructed at a distance of 500 to 1,000 feet from the wharf front yet transfer its contents quickly and without difficulty. The endless belts are connected with the discharging bins and carried to the wharf front



THE ELEVATOR AS COMPLETED, READY FOR SERVICE.

in closed galleries. Along the wharf is constructed another conveying system divided into convenient sections, and each provided with marine spouts. Each section of the wharf conveyor is fed by a conveyor belt from the elevator, so that one section can be operated independently of the others or all operated at one time, according to the number of vessels to be served. An example of this method is shown at New Orleans, where a storage and transfer house of 1,500,000 bushels capacity is being constructed by the Illinois Central Railroad Company. The building, which is of frame design, is located over 500 feet from the river front and is to be provided with four lines of



INDEPENDENT ELECTRIC MOTORS DRIVING SUCTION FANS.

belt conveyors running through double belt galleries and connecting with a series of wharf conveyors aggregating 2,000 feet in length constructed in four sections of 500 feet each. Each section will have a loading capacity of 20,000 bushels an hour. The elevator is being built of wood suported on a concrete foundation, and will receive grain by means of automatic steam shovels unloading the cars which are run into the building on depressed tracks. It will be operated entirely by steam power.

This plan of transferring grain has several advantages, as the elevator can be erected on a site which might be vacant and serve its purpose without interfering with buildings which might be located between it and the harbor. At ports where the shore of the river or bay is so soft as to require an expensive artificial foundation to sustain the weight, the building can be placed inland on a firmer and less costly site. Another advantage of the plan followed at New Orleans is that the damage caused by flooding the banks during high water is likely to be avoided. In rivers like the Mississippi, which are subject to great and rapid increase in depth special precaution must be taken to guard buildings near the shore from the possibility of such freshets.

THE STATUS OF THE NAVAL ENGINEER.

By Charles M. Johnson.

THE ENGINEERING MAGAZINE'S attitude on the question of the status of the naval engineer is inspired by an earnest desire to see justice done the profession, and a logical adaptation made of naval organization to modern conditions. This motive placed us in the front of the advocacy of the Personnel Bill, and animates our continuance in the campaign to make that bill as effective in administration as it was in conception. Mr. Johnson's excellent paper is presented as an object lesson, to show the powerful effort which is being made for a similar cause in the British Navy.—THE EDITORS.

THE present condition of the engineering branch of the British Navy is so bad that I can conceive of no lower depth of unsatisfactoriness to which it could possibly attain. The unsatisfactoriness to which I refer is not that seen from the standpoint of the engineer officer; that were to take far too limited a view of the question; but it is that seen from a far higher standpoint, that of the national needs, and the security of the State. Taking this point of observation, we are able to get a little above the clouds which must of necessity surround—and to a certain extent obscure—the lower position. It may be objected by the other side:—"How can you, as a naval engineer, take up an impartial position on a question which so closely interests and affects the class to which you belong?" I am not going to waste the valuable space placed at my disposal by the editor in trying to prove my impartiality; the best proof of the possession of that virtue will be the contents of the pages which follow.

The engineering branch of the British Navy is suffering in efficiency from three causes:—the want of training, the want of a sufficient and efficient staff, and the want of adequate rank and authority. I propose to deal with the whole question by the elucidation of the three points given above, taking them in the order in which they stand.

Training. It cannot be necessary for me to demonstrate to the readers of THE ENGINEERING MAGAZINE the inseparable bonds between training and efficiency. As practical and professional engineers they know, equally as well as I do, that efficiency in the handling of machinery can be acquired only by constant practice and experience—in other words, by training. We see the perfection of this probably in the "steaming staff" maintained by the various engineering and ship-building firms throughout the world almost exclusively for the purpose of putting the ships and machinery they build through their official trials.

They do not take men at haphazard out of their shops for such duties, but carefully select them from time to time, as opportunities afford, from observation of their behavior and their technique—if I may so term it—in the engine room and stokehole; so that in the course of time the manager has obtained a corps of steam-trial experts, which he knows may be trusted to get the very last ounce of steam out of the boilers, and the last quarter of a revolution out of the propeller. In this case, the experts are always dealing with the products of one firm, and the tricks and peculiarities of the type of engines and boilers they turn out will in nearly all cases be of the same nature; hence these men acquire such dexterity and skill in the handling of their firm's boats that it takes the ship's crew some little time, even with old and skilled hands, to get anything like the same results out of the machinery, either as to speed or economy. But in the British man-of-war, the engineer has much greater odds against him. In the first place, the machinery of the ship he is to-day called upon to take to sea may be of a type and make altogether new to him. In the next place, his staff will certainly be inadequate in point of numbers. In the third place, that staff will probably consist, as to one-third, of absolutely raw hands, some of whom may never have been in an engine room or stokehole when fires were alight and the engines moving. And this condition applies not only to the stokers, but also to the artificers. Let us take an imaginary example—H. M. Battle-ship Sphinx completed last year, having gone through all her official trials with credit to her builders and to the firm which engined her. She is newly commissioned for the China station. Being a first-class battle-ship, her engine-room complement consists of the following ranks and ratings:—One chief engineer, five engineers or assistant engineers, fourteen engine-room artificers, twenty-two chief and leading stokers, and one hundred and twenty-four stokers, and stokers second class. We must analyse this staff a little, and see what proportion of trained men it contains. There is first, the chief engineer, and his first lieutenant, the senior engineer; they are, of course, fully trained and experienced men, and it may be that two of the assistant engineers also have had a couple of years' sea experience—not training; then, out of the fourteen engine-room artificers there may be five with eight to ten years' service, and possibly other five with two to seven years' service. Of the twenty-two chief and leading stokers, there will probably be twelve thoroughly experienced good men; whilst of the remaining ten, one-half may be considered of little value, and the other half as men of ordinary ability. Of course all leading stokers must have had five or six years' service

before they can be rated "L. S." Of the one hundred and twenty-four stokers and stokers second class, one-third to two-fifths will certainly be raw recruits who have never been to sea, and whose only training has consisted of pitching stones and sand into a cold furnace and steaming a boiler to run auxiliary engines. To sum up:—out of an attenuated staff of one hundred and sixty-six officers and men, quite one-fourth consists of untrained raw recruits.

Now it is this want of a proper system of training the officers and men of the engineer department which I wish most particularly to emphasise. The question which I have so often asked of the general reader, I now ask of professional men, who will have no difficulty in answering: "What is the use of possessing the largest and finest navy in the world, if its value is seriously discounted by the want of 'trained' officers and men to handle its ships?" No expense is spared to train the officers and men of the sailor branch—(and rightly so)—for the important duties they have to perform, but is it wise, is it just to the country, wholly to neglect that part of the ship's crew upon which must ultimately depend the success or failure of the conflict?

Reverting to the crew of the Sphinx as above dissected, it will be seen that two assistant engineers are debited as "untrained" or only very partially trained. The training of these young officers in engine-room or watch-keeping duties is limited to a short period of steaming, and the examination and adjustment of the machinery of a small gun-boat at Devonport, during the last six months of their studentship. The course consists partly in steaming the vessel in the basin at Keyham, and partly in the Channel. But the actual time under steam is very limited, on account of the time which has to be devoted to scholastic work; so that this training is disconnected and of little real value as a preparation for engine-room watch-keeping duties. Again, it is limited to one small steamer, to one make of engines, and to one class of boiler, while the naval engineer may have to deal, in the course of his service afloat, with a dozen types of engines and boilers.

The engine-room artificer is in even worse case, for there is no training at all, provided for his class. In nineteen cases out of twenty, the engine-room-artificer recruit is a workman from the bench or forge, utterly unacquainted with engine or boiler, except from the building or repairing side, and in many cases, innocent even of that. It is quite possible that he may never have seen either a pair of marine engines or a boiler, until he finds himself in the engine room or stoke-hole of a ship in one of the reserves; and it is also possible that that may be the limit of his experience of marine engineering, until he is

drafted to H. M. S. Sphinx as part of the engine-room complement which is to take her to the most distant part of the world, and keep her going in full state of efficiency for three years.

The stoker recruit, like the engine-room artificer, has in very few instances any idea of a marine engine or boiler. He may possibly know the difference between a locomotive and its tender, but he will not know the blow-off cock from the regulator, nor the reversing lever from the brake. In many instances, he will have come from the fishing boat or the plough-tail, from the builder's yard or the livery stable; he is, in fact, utterly innocent of any knowledge appertaining to the calling he has undertaken to pursue. For years engineer officers have endeavoured to convince the Admiralty of the necessity of training for the stoker second class, but without avail, until within the past year or so they have inaugurated a burlesque system of training for these men which is so utterly ridiculous that I wonder their lordships were not ashamed to sanction it. That course of "training (?)" is as follows:—

On joining the service, the stoker recruit passes for the first three months into the hands of the seaman drill-instructor, by whom he is taught to march, to do all kinds of physical drill, to use a rifle and cutlass, to pull an oar, and all that is necessary for a blue-jacket to know as his preliminary training. At the end of the three months in the sailor's hands, the stoker recruit is handed over to the engineer department, and undergoes four weeks' training as follows:—

First week—Shovel drill with stones.

Second week—Shovel drill with stones.

Third week—Light fires in boiler, attend fires, run auxiliary machinery, etc.

Fourth week—Make packing and gasket, trim lamps.

During this training, the recruit is also instructed in a "Manual" specially written for his benefit. This manual gives the names and explains the uses of the principal parts and fittings of the engines and boiler, the names and uses of the various tools and stores used by the engineer, and instructions as to what it is necessary to do, and to remember, when raising steam. At the end of this four weeks' drill the stoker recruit is returned to the depot for disposal; which means that next week he may be drafted to H. M. S. Sphinx as "part complement." Observe the difference in value in the two trainings, as appraised by the executive mind. For the duties which at most can but be subsidiary duties, the time allotted for trainings is three months; for those for which he has joined the naval ranks, and which are to

constitute his life's work, one month is thought sufficient, and even that short period is wasted, or partly wasted, in a travesty of training.

The value of a first-class battle-ship is about a million sterling. The value of all the ships in the British Navy is in the vicinity of one hundred millions. The cost of maintaining a thorough system of training for engineer officers and men would not exceed one-tenth of one per cent. per annum on that amount. As we cannot get the full value out of our ships without this training, would it not be a wise investment of national capital to incur that cost? As there is the possibility of failure in war without this training, should not the British taxpayer insist on the elimination of that possibility, thereby affixing the stamp of his policy of insurance?

Inadequate staff. If, in addition to the want of an efficacious system of training assistant engineers, engine-room artificers, and stokers, the value of British naval ships be further discounted by insufficiency of numbers, my readers will recognise the unfair position in which the engineer officer finds himself, when called upon to take one of His Majesty's ships to sea for a three years' commission. In however high a state of efficiency the machinery, boilers, auxiliary machinery, steamboats, water-tight doors, hydraulic appliances, and double-bottom compartments may be on leaving the home port, the chief engineer knows full well that deterioration dates from that day. He will do his best, and his officers and men will loyally assist him as far as it is in their power so to do, to keep things right and in thorough working order; they will generally submit cheerfully to work more hours than any other men in the ship; to forego leave and other privileges, when there is work to be done, which must be left undone if they do not sacrifice their pleasures to the "exigencies of the service." But all this loyalty and all these self sacrifices do but minimise the evil; they cannot wholly prevent it. Then on arrival at the port which is the headquarters of the station to which the ship is allocated, with a fairly long list of defects to make good, the engineer finds that he has to send his men on leave, the same as the rest of the ship's company—which is of course quite right, though very inconvenient at such a time; and when the leave is over, the captain, under orders from the commander-in-chief, tells the chief engineer that one-half or one-third of his men must be sent ashore to drill. It is useless to represent to the captain that the work of preparing the ship again for sea will thereby be delayed. All that the captain can reply is, "I am only carrying out the station orders." An appeal to the commander-in-chief would probably invoke the reply: "The station orders are to be obeyed." What the engineer feels

is, that he is unfairly handicapped by these orders. He says rightly enough: "Let me get the ship ready again for sea, and after that take my men, and drill them according to the station orders." But that is not the way in the navy. The executive officer is supreme, and having the power to get his work done first he uses it. The engineer is responsible to the captain for getting the ship ready for sea, but it seems to be no part of the captain's business to help the engineer.

There is no more difficult task than that of demonstrating to the lay mind that the number of officers and men allowed to the engineer department of a ship of war is insufficient for the duties to be performed and the work to be accomplished. Little as it can help to an appreciation of the real inadequacy of the staff, yet it may be as well to give here a list of the engineer's duties and responsibilities as laid down in Chapter XXVI of the Queen's Regulations and Admiralty Instructions of 1899:—

"The Engineer officer is to have charge of, and to be responsible for, the maintenance in a state of efficient working order, and as far as may be of readiness for immediate use, of all that is placed under his charge, including:—

(a) The machinery and boilers of the ship and her boats.
(b) All auxiliary machinery, except electric motors, for whatever purpose fitted.
(c) All pumps, with the cocks, valves, and pipes belonging to them.
(d) All distilling apparatus.
(e) All gun mountings.*
(f) Propeller-lifting apparatus.
(g) All steam and hydraulic pumping and other engines for loading and working the guns, for supplying ammunition, and for turning turrets, barbette platforms, etc.
(h) All ventilating engines and gear, except the motors of electrically driven fans.
(i) Capstan engines, shafting, spindle of capstan, and windlass and steam-steering engines and gear as far as the rudder, with spare gear for the same.
(j) Hydraulic jacks, with the exception of those in the gunner's charge.
(k) Steam winches and gear for hoisting torpedo and other boats.
(l) All water-tight doors and sluice valves, including horizontal trap and flap doors as well as vertical hinged doors.
(m) Steam fire-engines and all pipes, cocks, and valves in connection with the fire-main.
(n) Instruments and gear (not electrical) for telegraphing signals in connection with the machinery.
(o) Whitehead torpedoes and submerged discharge tubes and gear.*
(p) All air-compressing machinery, reservoirs, separators, and charging-columns.
(q) Electric-light engines and dynamos.*
(r) All flooding gear, including pipes, cocks, valves, and other fittings.

(s) All such other parts of the hull, double-bottom, and exposed iron surfaces, as may be in his charge.
(t) Ice-making machines.

* These items have, by a recent order of the Admiralty, been wholly or partially transferred to the gunnery and torpedo lieutenants. These officers have, however, to be trained as mechanical engineers before taking over their new duties. It does not therefore appear probable that these duties will pass out of the hands of the engineer officers at an early date.

After toiling through this formidable list of duties, the non-naval man may naturally ask what is left for the rest of the officers and men to do? Well, not much of any importance—chiefly keeping the ship, boats, guns, anchors and cables, masts (if there be any), and the outside of the hull, turrets, and superstructure, clean and well painted. The rest of the deck work consists mostly of drills of various sorts, firing at a target once or twice a quarter, a good deal of soldiering when in harbour, and care of and stowage of provision. And to do this work be it remembered there are from three to four times as many of men as are allotted to the engineer. The basis of calculation for the engineer department is the number required to steam the ship at a little more than one-half the full-power of the engines, developed during her official trials. The utter inadequacy of this complement is seen whenever a ship has to do her quarterly trial. It is then found that to develop only four-fifths of her natural-draught power for twenty-four hours only, it is necessary either to put the stokers in two watches or to obtain assistance from deck. But in time of war, no captain would think of cruising about with any of his boilers out of use; he would take care that all his boilers were alight, and that he could have full power on his engines whenever he demanded it—certainly within fifteen or twenty minutes. It is also certain that at such a time the captain would be very unwilling to spare any men from deck to assist in the work below. In fact, according to the "Watch and Quarter Bill"—which shows the station of every man and officer in action, one-third of the engineer staff should be at their quarters on deck, not in the engine room at all. Well, we say, what is the use of keeping a ship in time of peace, on a complement which will not be able to fight her in time of war? There is not a ship in the British navy to-day which has an engineer complement sufficient to maintain her in a state of efficiency. If that be the case in time of peace, what will be the condition of the navy in time of war? It is no use blinking these facts. It will be too late to call on Lord Selborne, or Mr. Arnold-Forster, then, to give the ships adequate engineer staffs. They will not be able to get either the officers or the men who will be needed. If they are not in store they cannot be purchased outside. The requisite

engineers, artificers, and stokers, must be obtained now; must be trained and drilled, now. Suppose that Britain should find herself confronted by another European power to-morrow, or next week, or next month; do the readers of this journal imagine that the Admiralty could immediately commission all the ships she possesses? If so, let me ask how it comes about that a ship is waiting at Pembroke dockyard to-day* for a navigating party to bring her round to Portsmouth to complete her for sea? Remember, there are dozens of ships in the various fleet reserves, ready in all respects for sea except that one item—of so little importance (?)—that there are no men of the engineer staff to man them. If the men to man these ships were in depot, there would be no difficulty in making up a navigating party of engineer ratings to bring the Drake round from Pembroke. So it comes to this:—that not only are there not a sufficient number of engineer officers and men in the ships in commission, but there are not men enough, (even on the Admiralty basis of complement,) to put into the ships in the fleet reserves; and as ships without men are valueless, it is no use going to the taxpayer with the pitiful cry that Britain ought to have more ships, because France or Russia is building within ten per cent. as many ships as she is. She must first of all be sure that the ships she has are fully efficient in every respect, and that at the outbreak of war she is prepared to the last stoker recruit; and after that it may be reasonable to talk of increasing the number of ships.

There is little doubt that the Admiralty are under the optimistic conviction that if war broke out, they would have very little difficulty in filling up the ranks of the engineer branch from outside sources. If it be a question of numbers only, without any reference to fitness as regards qualifications, Yes. We who are old enough can remember how the gunboats were officered and manned in the engineer department for the Baltic and the Crimea. How the Admiralty had to go hat in hand, with a recruiting officer in full uniform with a big brass band playing and flags flying, to all the factories and gas-works throughout the country, picking up all and sundry who could aspire to claim acquaintance with a furnace, a boiler, or an engine. What a tag-rag and bob-tail lot they were, and what infinite sport they afforded to *pukkah* engineers of the navy, when these were not too greatly exasperated with their fathomless ignorance to be able to appreciate the humour of the situation. These men were brought into the navy on pay of 12s. 6d. per day, and put under the orders of naval engineers receiving only 7s. 6d. per day, although to have obtained that rate of pay meant at least six years' service, or its equivalent. I

* 20th Feb., 1902.

believe also that these men received a bonus or sum of money to provide their outfit. The traditions of the Baltic and of the Crimea doubtless cling about the Admiralty still—at least, it would appear so, if one may judge from the strictures of a gallant admiral who took exception to the figures which I quoted in some articles I wrote about the end of 1900, in connection with this subject. Admiral Freemantle said: "If Mr. Johnson, or those he quotes, mean to imply that we have not enough stokers to man all the ships we could possibly commission, I reply that they have no knowledge as to what these ships are, or how far we are prepared to man those required." Here the admiral hints that 'we' (he was not an Admiralty official at that time [nor is he now,] but he lets us know that he is in the confidence of the board,) have got a trump card up "our" sleeve which is beyond the ken of all outside the charmed circle. But as most of us know, quite as well as any admiral can know, the sources which remain to be tapped, I think we are quite as well able to judge of the results of those sources when tapped. As to not knowing what ships are likely to be required if war should break out, I think the admiral would find no difficulty in getting that out of the "man-in-the-street." Every ship we possess and as many more as we can lay our hands upon! Now, that the Admiralty would succeed in getting the *number* of men they wanted in time of war can hardly be doubted; but of the *quality* of the men raised and *their cost to the country*—these are among Admiral Freemantle's trump cards, up the Admiralty sleeve.

In concluding this part of my subject, I will cite some instances which I hope will prove conclusively to the minds of my readers that engineer complements for the ships of the navy when filled up according to Admiralty schedule are not sufficient for the independent working of the ships. Take the ships which accompanied the Ophir in her tour with the Prince and Princess of Wales:—If Admiralty complements are sufficient, why was more than forty per cent. of engineer staff added to their crews, before they started on the voyage? And why, when a newly commissioned ship proceeds on her commissioning trial at natural-draught power, is it found to be necessary to send a steaming party to assist her own complement, during that trial? Is it not the consciousness on the part of the Admiralty officials, that with the Admiralty complement alone the required results could never be got out of the engines and boilers?

Inadequate authority. I come now to the third cause of imperfect efficiency, which environs the engineering branch of the naval service, viz., the want of military control and command in, at least, their own

department by the engineer officers. I say, in at least their own department, although I see no reason why they should be thus "cabin'd, cribb'd, confin'd" in the exercise of this indispensable adjunct of efficient handling of large bodies of men on board ship; being of the same opinion as the late Admiral Charles Fellowes, that the engineer officer should have the authority necessary to enable him to give an order to any man in the ship, without the danger of that man daring to disobey, or even to question the order.

At the present time, as during the sixty years which have elapsed since steam was first introduced into the navy, the engineer officer is in the civil branch of the service. Being a civilian, the naval engineer has no power to reward zeal, energy, or competence, nor to punish idleness, neglect of duty, or insubordination. The good or the bad man must in either case be sent upon deck to be dealt with by the executive officer; and the very fact that his own immediate officer has not the power to mete out punishment nor reward is more firmly imprinted on the subordinate's mind every time he is sent up to the executive officer. This condition of affairs cannot be conducive to the development of discipline among the rank and file of the engineering department, however much the officers of the military branch may seek to minimise and depreciate its real power in order that the engineers may not invade the sacred precincts of the military cordon. The following extracts from the writings or speeches of executive officers on the subject will show, that while some of them are contemptuously agreeable, others are bitterly antagonistic; and but a solitary individual is sympathetically in favour of the proposal that the engineers should be given military or executive rank and command, strictly limited however, to their own department:—

"But their claim to 'executive rank' involves a far higher pretension than this. . . . . It is a demand for power to 'punish their own men.' This matter is discussed as if anybody is competent to punish." *(Capt. A. C. C.)*

"Already the engineers are calling out for executive rank and titles. This is quite natural as they see that they do most of the work, and that the maintenance of our modern ships in a state of fighting efficiency is the business of mechanics and not of sailors. I do not think the engineers will get their wish just at present, but this agitation is a sign of the times which must not be ignored, and it is not difficult to see that unless our executive—both officers and men—receive a more mechanical training than they do at present, they will be gradually ousted by the engineers and artificers." *(Rear-Admiral L. C. P. F.)*

"Why should not these engineers have executive rank? It is merely taking command of a certain number of their men, which at present they do as much as any so-called executive. Then why not call them executives as, of

course, they play a very important part in the ship? If it pleases them to be called executives, and we get better work out of them in consequence of calling them so, and they achieve, as they think, a better position, it will hurt nobody and will content them." *(Admiral Sir J. O. H.)*

"And now let me touch on the vexed question of the position of the engineers, and suggest that the time has arrived to accord them executive rank. Their duties are purely executive and should be recognized as such, and the recognition cannot, in my opinion, clash in any single instance with the other executives as their sphere of duty is so clearly defined, and an engineer would as little expect to be put in charge of the navigating or officer of the watch's duty as would these officers of being put in charge of the engines. Then as regards power of punishment for delinquencies committed by stokers in the engine and boiler-rooms, why should not chief engineers have the same power of minor punishment allowed them as a commander, second-in-command, a first lieutenant, etc.? If this were permitted it would tend largely to improve the chief engineer's position and strengthen his authority." *(Ibid.)*

It is apparent even in the last and most favourable of these quotations that the concession there made is the result of unwilling conviction. Nothing is so bitter to human nature as to have, or to fear to have, to relinquish the post of honour in favour of a new claimant, or even to share part of the honour with him. And this is what the executive branch of the navy has had sitting on its chest like a night-mare for the last forty years. Yet, had they looked the question fair and square in the face, they would have seen that there was little cause for panic or alarm. What the engineer officers are asking for is the power and authority to deal with their own officers and men, in the matter of rewards and punishments, without the interference of any executive officer, other than the officer in command. As to succeeding to command, that might be advisable under certain conditions, under peculiar circumstances, when it would be to the direct advantage of the service that the command should devolve upon the engineer. It is not the purpose of this paper, however, to enlarge upon this somewhat remote phase of the subject, but rather to show cause why the engineer must be invested with executive rank and authority if, in the next naval war in which the country is involved, she is to come out crowned with victory. Omitting the supreme command, the handling and fighting of the ship in actual war, and deducting from the remaining duties which have to be performed those devolving upon the engineer as detailed on page 238 preceding, we see that the most important of the residual duties consists in handling the guns and firing the torpedoes, and that even these duties cannot be efficiently discharged except in absolute dependence upon the engineer. So that, as Admiral Fitzgerald wrote in his very able article entitled "Training of Seamen in the Royal Navy," (*National Review*, June, 1900) :—

"Almost everything is now done on board a man-of-war by machinery; manual labour is nothing; and the tendency is to increase the machinery, and to do nothing by hand which can be done by steam, electricity, or hydraulics. Not only the motive power, but the fighting power of our ships is all machinery. In the old days 'Jack' could repair all ordinary damages himself. . . . . Now he has practically nothing to do with the up-keep of the ship, ... and the ship can only be kept as a going concern by the engineers, E. R. A.'s, etc., etc. . . . . These men and these alone can maintain for one week, or for one day, the fighting efficiency of a modern battleship or cruiser, or even a torpedo-boat destroyer. . . . ."

Admiral Fitzgerald recognizes to the full the importance of the engineer, and the enormous responsibilities devolving upon him. Great responsibilities demand commensurate power and authority for their efficient discharge. Can it be considered that adequate rank and authority have been bestowed upon the engineer, when it is possible that the senior fleet engineer on the list may, under certain conditions, be subordinate to a young sub-lieutenant, or even to a warrant officer? Instances have occurred in the British fleet reserves where the orders of the fleet engineer have been set aside by the warrant officer in command. On appeal to the captain of the naval depot, the engineer could obtain no redress because, said the captain, the warrant officer represents me. What an undignified—not to say degraded—position for an officer ostensibly holding the rank of commander in the navy, and that of lieutenant-colonel in the army, to be placed in! The very mention of such a possibility should be sufficient to condemn the regulations which render it possible; and still more, the administration responsible for the retention of such antiquated and old-time regulations. In peace, such an anomalous position, however irksome and distateful to the engineer, may not result in any considerable amount of harm to the service. But the *raison d'etre* of the navy is as a fighting machine; and to be in all respects prepared for war, it is necessary that the administration and discipline of the navy shall be upon the war basis in time of peace, so that it shall not be necessary on the declaration of war to make any changes in the system under which it has hitherto been administered. Some fifteen or twenty years ago, the men under the chief engineer's orders belonged to the executive of military branch of the service, the engineer then, as now, being in the civil branch. It was about this time that considerable prominence was given to the engineers' claim for executive rank and titles, both in parliament and in the press, owing to the fact that the committee of 1873, of which Admiral Sir Astley Cooper Key was president, had reported in 1877 in favour of giving executive rank to the engineer; and

the friends of the engineers thought that when advocated by an Admiralty committee, consisting of three officers of the executive branch and only two engineers, the Admiralty would have no hesitation in adopting the report. The Admiralty, however, refused to adopt that part of the report, and have done so to this day. Then it was that the anomaly of a civil officer being in charge of men of the executive branch became such a powerful lever in the hands of the press and of members of Parliament in advocating this reform; and at last in self-defense, and to destroy this valuable weapon in the hands of persistent pleaders that justice might be done to the engineers, the Admiralty entirely revised the lists of the executive and civil branches of the navy. The artificers and stokers were removed from the executive, and placed on the civil list. Sooner than do justice to the engineers they preferred to do an injustice to a large and loyal body of men against whom they had no charge, whom they had always found of the greatest service when called upon to assist the deck hands, and who, they were bound to admit, were among the must valuable men in the service.

It is often urged by executive officers that executive rank is not necessary for the engineer, as he already controls his men efficiently. This is begging the question. The engineer controls his men simply by force of circumstances; but he desires that he should be put in the more logical position of being officially endowed with the authority and power which under existing conditions he is obliged to grasp.

Whilst this question of the naval engineer is one of interest to all civilian engineers, it should be of even greater importance to the taxpayer, who looks upon the navy as the national policy of insurance. The taxpayer may rest assured, however, that the navy will not be in a fully efficient condition until these three things are established within its *régime*, viz:—

(a) The immediate introduction of a thoroughly efficient system of training in sea-going ships of all engineer ranks and ratings, before allotment to commissioned ships as part-complement.

(b) An increase in the engineer staff in all ships, to such an extent that with the staff in three watches, it shall be able to steam the ship at not less than the natural-draught power for as long as her coal lasts, and at the same time be able to manipulate every auxiliary engine or machine, in action, without any assistance from the deck.

(c) The investment of the engineers with executive rank power, and authority "corresponding to the greatness of their present trust, and to the weight of their enlarged responsibilities."*

* Sir E. J. Reed's letters to the "Times," 1877.

THE FALSE WITNESS OF THE TEST BAR.

By Robert Buchanan.

The possible, but generally neglected, economies of the foundry afford one of the most promising fields for improvement of practice and reduction of costs in engineering manufactures. THE ENGINEERING MAGAZINE will shortly announce a comprehensive series of papers, now in preparation, dealing practically with advanced and economical foundry management. Meantime a strong interest attaches to Mr. Buchanan's article questioning the soundness of the usually accepted standard for judging castings.—THE EDITORS.

THE production of castings, the acceptance or rejection of which depends on tests—tensile or transverse, or both of these—considerably increases the responsibility of the people engaged in such work. It may be granted at once that the necessity of having iron of a quality which will give satisfactory tests, naturally results in a closer attention being given to the mixing of irons than would be the case were the castings, or bars representing them, not subject to test. In spite of the fact that cast iron equals in importance any other metal whatsoever, it has suffered a most serious neglect, few efforts being made towards a due understanding of it. This neglect may arise in some degree from the infinite number of modifications which the elements—iron, silicon, phosphorus, manganese, sulphur and carbon—may cause, and each modification still be classed as cast iron. If cast iron had a more definite limitation of composition, such as steel has, and if it were not so easily melted and cast, then we would have been forced to acquire a more precise knowledge concerning it.

Notwithstanding the facility with which cast iron may be melted and cast, the infinite variety of services which it renders us makes it incumbent upon us to see that full use is made of the best qualities of the metal, and that under the seeming simplicity of some of the operations employed, there is not room for serious error.

The test bar has always, I believe, been considered as affording a true index of the quality of the casting—that is, of course, when the test bar is cast with similar metal, and from the same melting of metal as the casting, though not necessarily both run at the same moment of time. The day was, and not so long ago either, when it was thought good, smart work to proffer, for testing purposes, test bars not of the same mixture or melting of iron as was used in the castings. The desire was to have satisfactory tests, such as it was

feared could not be obtained by ordinary cupola melting. Possibly to keep down the cost of the mixture charged into the cupola was one of the reasons for this doubtful procedure, but I believe the predominating reason was a disbelief in the foundryman's own ability to produce, by cupola melting, an iron suited to give the necessary tests. Another affecting cause may have been the fact that cast irons giving the highest tests are not the most easily machined. By giving castings easy to machine, and by supplying test bars ample for the tests required, a little lapse of memory regarding the doubtful origin of the test bars was all that was necessary to please the machinists and inspector alike. Such devices are, however, the refuge of none but the incompetent and unfit, and are such as have made the name of test bar the occasion for the sceptical smile, and, when good tests are made, the sceptical question: "Is it a genuine bar?"

Leaving such chicanery to the contempt which is its due reward, let us address ourselves to a consideration of the questions: Do cast-iron test bars give a true indication of the quality of the castings they represent, and if not, to what extent do they mislead?

By mixing irons of known composition, and knowing fairly well as we now do the changes which the metal undergoes during the process of melting, we can tell, within a small margin of error, the chemical composition of the metal as it stands fluid in the ladle. With iron in the molten condition one's power to alter or change it has practically ceased, except in two directions—one, the casting temperature, the other the rate of cooling. That these are of the utmost importance as affecting the quality of test bar and casting I hope to shew.

Grey pig iron has a total carbon usually over 3 and under 4 per cent., and of this, the combined carbon ranges from practically *nil* to 0.50 per cent., the remainder being graphitic carbon. Such is the condition of the carbon in iron when in the solid condition, but in molten iron the carbon is believed to be wholly in the combined form, and we may by slow cooling cause the separation out of the greater part of the carbon as graphitic carbon, or by quick cooling retain a large percentage of the carbon in the combined form.

I have cast metal into a casting which cooled in a few minutes, and kept some of the same metal so as to cool through a period of 120 hours. The combined carbon dropped from 0.508 per cent. in the quickly cooled metal to 0.020 per cent. in the slowly cooled metal, with proportionate increase in the graphitic carbon. Casting in chills is an example of the effect of quick cooling upon the retention of the carbon in the combined form. These instances show the two extremes in either direction, but varying effects are produced by intermediate

rates of cooling, although acting upon a metal of uniform initial quality. The carbon itself is inert as regards taking the graphitic form, but is influenced in that direction by the silicon. The "rate of cooling" is another way of expressing the period of time, be it less or more, through which the silicon is allowed to act upon the carbon by causing it to separate out as graphite, before the temperature of the metal drops too low for such action to be effective.

To some degree silicon may be neutralised by sulphur, but in grey cast iron such a neutralising can only be very partial. Sulphur undoubtedly has the power of causing the combined carbon to retain that form and so cause hardness, but any hardening of the iron so caused is exceeded by the direct hardening of the sulphur itself. If castings are heavy and so take a considerable time to cool, the silicon under such conditions will gradually reduce the percentage of combined carbon, notwithstanding the presence of sulphur. If combined carbon be present in very minute quantities, then such castings are soft and weak from excess of graphitic carbon. Greatest general strength is obtained when combined carbon is present from 0.5 to 0.6 per cent., other constituents being normal. Seeing that a fairly definite percentage of combined carbon is necessary in the best and strongest irons we can produce, it follows that we must vary the percentages of silicon as the castings are light or heavy. Light castings cool quickly and so the silicon is kept high. In a heavy casting, cooling through as many hours, perhaps, as the other does minutes, the silicon is kept low. For greatest general strength each should finish cooling with somewhat similar percentages of combined carbon.

The mixing and casting of iron is successful only in so far as the product conforms to the chemical and physical laws governing the constitution of a mixture suited for a particular purpose. Bearing these things in mind we may now consider whether test bars give a true indication of the quality of the casting they represent, and if not, to what extent they mislead.

The following observations refer of course to test bars cast from similar metal to that which goes into the castings. The test bars may be cast separately or may be run from the casting itself, in which latter case the test bar cools along with the casting. When test bars are run separately they are almost invariably cast hotter than the castings they are to represent, and this has a material effect on the strength of the test bar. This is in favour of the test bar as compared with the casting, which is usually cast dull. The reason foundrymen cast heavy castings with iron below the hottest and most fluid condition, is because they desire to avoid the "searching" action of hot iron by which

the carbonaceous material of the mould would be burned out, and the iron still have enough fluidity left to take the place of the burnt-out carbon. The result would be a rough casting. One other reason is, a widespread belief that hot iron readily causes "scabbing" of the mould, and another reason is, that where "feeding" a casting is required, casting "dull" shortens the period required for feeding. Foundrymen get very skilful in judging the temperature and fluidity of the iron so as to fill the mould perfectly and yet avoid the dangers mentioned.

In the following test a casting weighing 36 hundred weight was run, and attached to it and run by the metal when the mould was almost full, was a test bar "A"—41¾ inches by 2 inches by 1 inch. The bar was horizontal when run and was situated about 12 inches from the large casting. A bar "B" of similar size was moulded separately. The iron for bar "B" was taken from the large ladle holding over 2 tons of iron to run the large casting. It is desirable to take the iron for test bars from the metal in bulk; taking it direct from the cupola is apt to cause error, as pig iron alone or scrap iron alone may be caught in the small ladle. Getting iron from the large ladle ensures that what goes into the test bars is exactly similar to that which goes into the casting. The test bars separately cast were cast "hot," the casting and test bar attached cast at the temperature and fluidity of metal customary in such cases. I cannot say exactly what the difference of temperature between the two irons would be, but have to fall back on the shop terms, "hot' in one case and "dull" in the other.

(1) TRANSVERSE TEST—36 INCH CENTRES.

	Deflection.	Breaking stress.
Bar A, 2 inches by 1 inch, run from and cooled with large casting	3/8 inch	26½ cwt.
" B, 2 inches by 1 inch, cast separately.....	7/16 inch	31 "

Difference of breaking stress = 16.98 per cent.

Bar A had combined carbon 0.490 per cent., but bar B had combined carbon 0.450 per cent., combined carbon in the casting at heaviest part, a trace only. Probably bar A would have had less combined carbon if the "git" which connected it to the casting had not been broken while it was still hot. The bar thus cooled more rapidly than it would have done had the connection remained unbroken.

(2) TRANSVERSE TEST—36 INCH CENTRES.

	Deflection.	Breaking stress.
Bar C, 2 inches by 1 inch, run from and cooled with casting	.....	25½ cwt.
" D, 2 inches by 1 inch, cast separately.....	.....	28½ "

Difference of breaking stress = 11.76 per cent.
Combined carbon in C = 0.427 per cent.
" " " D = 0.415 " " or a difference of 0.012 per cent. less in the separately cast bar.

As shewing the differences which may exist betwixt a test bar separately cast and the casting it was meant to represent the following was noted:

	Combined Carbon.
Test bar separately cast	0.499 per cent.
Casting bored at heaviest part	0.101 " "
Difference	0.398 " "

In the casting the low combined carbon means a high graphitic carbon, and high graphitic carbon, as I have said, means weakness.

To make trial in another direction, it appeared that test bars cast from metal mixed to give soft grey castings with a thickness ⅛ inch or little over, would give too low results, the castings being really stronger than the test bar. In order that the light castings may be grey, silicon should be present from 2.50 to 2.60 per cent. Such a percentage will give a graphitic, open-structured area in the centre of a bar 2 inches by 1 inch, and so will weaken it. Test bars to indicate the quality of light castings, however, are not much used, but were they used oftener, some uncomfortable results would follow. Iron giving strong test bars would make light castings hard; iron which makes light castings soft would make weak test bars.

Iron of a quality to run light grey castings was caught in a ladle, and from it were cast two bars 41¾ inches by 2 inches by ¼ inch; then two bars of a similar length, 2 inches by 1 inch. These were cast with hot metal as it came from the cupola. When these were cast the remaining iron was kept in the ladle until it was judged to have just sufficient fluidity to run the two remaining bars, also 2 inches by 1 inch. The latter bars were so treated as to give an indication of the effect of casting with iron at a temperature lower than that of the iron when first obtained. Each of the bars mentioned was moulded in green sand and cast horizontally, being run from one end, and was allowed to cool in the sand.

(3) TRANSVERSE TEST—36 INCH CENTRES.

	Deflection.	Breaking stress.
Bar E, 2 inches by 1 inch (cast hot)...		24 cwt.
" F, 2 inches by 1 inch (" ")...	5/16 inch at stress of 20 cwt.	
	3/8 " " " " 21 cwt.	
	3/8 " " " " 23 cwt.	
	3/8 " full " " 24 cwt.	24¼ cwt.

NOTE.—Fractures had open structure at centre. Small bright crystals all over. Bored very soft.

	Deflection.	Breaking stress.
Bar G, 2 inches by 1 inch (cast dull)..	¼ inch at stress of 20 cwt.	21½ cwt.
" H, 2 inches by 1 inch (" ")..	¼ " " " " " "	20 cwt.

NOTE.—Bar H was a little under size and broke immediately after reading of deflection was taken. Fractures of both bars were less brightly crystalline than the bars cast hot, and had not the open structure at middle of bar. Bored very soft.

	Deflection.	Breaking stress.
Two Bars I, 2 inches by ¼ inch (cast hot)	5/16 inch at stress of	14 cwt. 15 cwt.

NOTE.—Area of the two bars = 1 square inch. This equals a breaking stress of 30 cwt. for a bar 2 inches by 1 inch. The two bars were put in the testing machine side by side, and the deflection would probably have been greater had there not been considerable torsion due to the thinness of the bars. Both bars broke at the one instant, one breaking 1½ inches from centre of pull and the other 2 inches from the centre, but on the other side of centre line. Fracture finely granular and lighter in colour than either of the other bars. Avery's transverse testing machine was used.

COMPARISON OF BREAKING STRENGTHS.

Bar F, 2 inches by 1 inch (cast hot) is stronger than bar G (cast dull) by ..... 12.79 per cent.
Two Bars I, 2 inches by ¼ inch (cast hot) together are, area for area, stronger than bar F by ..... 23.71 per cent.
Two Bars I (cast hot) are, area for area, stronger than bar G by 39.53 per cent.

These are astonishing differences to obtain from one ladle of iron, and are wholly due to different casting temperatures and rates of cooling. The thin bars bear somewhat the same relation to the bars 2 inches by 1 inch, which these bars bear to a heavy casting. Test bars are cast hot and cool quickly; the castings are run at a much lower temperature and cool slowly. The analogy needs no elaboration.

Tensile tests of two bars connected with and run from a casting but at differing distances from it, exemplify the effects of quick and slow cooling upon the strength of the test bars. I do not wish it to be concluded that such great differences always occur; but that the rate of cooling makes a great difference between test bar and casting in most instances, I have no doubt whatever. A large casting was run, and connected with and near to the heaviest part of the casting there was a bar designed for a tensile test. Another similar test bar was run from the casting but was further away, and so was less subject to the heat-retaining effect of the casting.

TENSILE TEST.

	Breaking Stress per square inch.
(1) Test Bar, furthest from casting	14 tons.
(2) " " nearest casting	5 tons.

The analyses of the two bars were practically identical except as regards the carbon.

	Combined Carbon.	Graphc. Carbon.	Total Carbon.
(1)	1.129 per cent.	2.356	3.485
(2)	0.671 " "	2.836	3.507

How are these great differences to be accounted for and to what are they due? I believe they are caused partly, in most cases, by the rate of cooling reducing the combined carbon to a point under that which gives greatest general strength, and in the case of heavy castings the combined carbon may almost wholly disappear. There is a double effect in the latter case, the combined carbon, which should add strength to the whole, appears as graphitic carbon, dividing the molecules of iron and so weakening the cohesion of the whole mass. The

main cause of the great differences noted must, however, be sought for elsewhere, and is probably molecular disturbance, the result of casting at a comparatively low temperature and reduced fluidity. For best results then, it is necessary to cast hot, so that in the casting the molecules of iron, and the elements combined with the iron, may arrange themselves and so continue, undisturbed by any mechanical movement such as pouring.

In every test which I have made, the bar cast separate is strongest; the bar cast on, but furthest from, the casting, is less strong; and the bar nearest the casting is weakest. To which test bar is the casting most nearly related? Certainly to the weak bar. I am afraid that what has weighed most with founders in the past is less the making of strong castings than the production of satisfactory test bars.

In the United States recently, a committee composed of noted foundrymen, after many tests and much labour of a painstaking character, reported to the American Foundrymen's Association, making certain recommendations regarding the best forms and sizes of test bars, mode of casting, and how the tests should be conducted.

The tests are to be made upon bars cast separately. That the results will be misleading as to the character and quality of the castings they are supposed to represent, I have no doubt whatever. They may be true of a casting of similar weight and section—that is, of another test bar; they will not be true of a casting perhaps five hundred times the weight of the test bar, almost certainly cast at a lower temperature, and certainly cooling through a longer period of time.

If the ordinary tests are unreliable what can we use in their place?

There should be greater use made of the "test-to-destruction" of a certain percentage of the castings indiscriminately chosen from the day's melt, as is done with car wheels for American railroads. Where such a test is not possible or would be too costly, then test bars ought to be cast on the casting itself and not simply run from it. Such test bars should be cast of a size to allow for machining off and still be standard sizes as ordinarily used.

By these means a truer indication of the character and qualities of the casting would be obtained, and substitution of false test bars would be rendered well-nigh impossible. Such a system of testing would have the effect of a revolution, and by the demand for a high-class material there would be forced upon foundrymen generally the absolute necessity on their part of a better knowledge of the metal with which they work.

THE FACTORY OFFICE.

ITS RELATION TO THE STORES DEPARTMENT AND TO THE SHOPS.

By Kenneth Falconer.

The fundamental conception underlying Mr. Falconer's articles is that the factory office, completely equipped and properly managed, should itself be a productive department, with profit-bringing functions extending from the time quotations are obtained for raw material until the finished product is shipped and bills sent to the customer.

His papers, which will continue throughout two succeeding issues of the Magazine, are effective adjuncts to Mr. Carpenter's most interesting current series. They exhibit the possibilities of money-saving organisation in the office, as Mr. Carpenter's show the results of money-making management in the shops.—THE EDITORS.

A STUDY of the relation a factory office should bear to the other departments of a manufacturing business will perhaps result in greater benefit if the nature of factory accounting and the object of a factory office as distinguished from cost accounting and a cost department are first stated.

Factory accounting includes all, but is a much wider field than that which may be covered by cost accounting. The ultimate object of both is, of course, cost reduction, but cost accounting seeks to enable the management to reduce costs, and is largely confined to the productive departments, while, in addition to acting as a thorough and efficient cost department, the factory office should itself be a strong factor towards cost reduction, by exercising a close supervision and a partial control over all the departments except the selling and the financial. A cost department is a clerical recording instrument—a factory office an executive department; cost accounting is a passive influence—factory accounting an active force. An effective cost system may very properly be operated as a part of the general office work, but the best results of a system of factory accounting can be obtained only when it is under the sole control of a department entirely separate and distinct in itself, whose work alone it is.

Even where the accounting department of a factory is entirely distinct from the commercial office, its scope and usefulness is very often limited to clerical work, and extends only from the time orders

for certain specified work or the manufacture of certain articles are put in hand, until completion or delivery to stock or shipping room. In other cases, in addition to clerical work and records, the factory office exercises during this period a greater or lesser control over the various works or manufactures as regards their claims for priority, or the relative urgency of their completion. In both cases it is assumed that during the progress of any work or manufacture any information regarding it should be instantly available upon application to the factory office, and on completion of orders their costs should be promptly made up and forwarded to the head office.

While these comprise a very important part of the proper functions of a factory office, they are yet only a part; and, no matter how completely and accurately done, the factory office whose usefulness is limited to these bounds is not being operated to its full capacity or at the highest degree of efficiency possible. Its information and data should cover all details, both direct and indirect, which in any way affect any department of the business, excepting only the selling organization and financial management. Its scope and authority, instead of being limited to the actual period of manufacture, should extend from the time a quotation is first sought with a view to estimating for certain work or for the manufacture of certain goods, until the work has been completed, or the finished article has left the possession of the company, whether it was made for an individual customer or was carried in stock for an indefinite length of time. Its records and results, instead of being confined to productive operations, should equally cover all material, equipment, maintenance, and operating accounts, and these to the utmost detail.

To operate a factory office on these lines would necessitate an efficient and well organized staff, though not necessarily a large one, and a thorough and complete equipment of modern filing devices and card indexes. Consideration of the effects in other departments will show that the increased expense would be more apparent than real; practically all the clerical work usually done in stores, shops, stock, or shipping room would be done in the factory office, thus leaving the heads of the other departments entirely free to attend to matters more directly concerning them, and enabling them to dispense with any purely clerical help they may have employed. The factory office being especially equipped for work of this nature its staff could handle it to greater advantage than the employees of any department where it is necessarily subordinate to work of another kind, and consequently to some extent, at least, regarded as a side issue.

All data of prices and quotations, all information regarding progress, location, and cost of work, all records of part completions and balance unfinished, of both manufacturing and shipping orders, being in the one office, it would not be necessary when complete information regarding the status of an order was required to make inquiries of any other department. It must be remembered it is not a question of obtaining full information regarding purchases or other transactions, but rather of the intelligent and systematic recording of such details in such manner that they may be most easily obtainable when required. The information itself reaches the company by various channels in the natural course of business, but its value is often lost owing to neglect of recording it. The additional expense necessary to keep it in easily accessible shape is very little, provided the department expected to do so is properly equipped for the purpose, and that the employee whose duty it is has free access to all sources of information.

This question of equipping and maintaining a factory office is the stumbling block that keeps so many manufacturers from enjoying the advantages that may be obtained by a thorough system of factory accounting. If those in control could see that the added expense would to some extent, at least, result in decreasing the operating expenses of other departments, if they would realize that the factory office is nothing more or less than a machine tool, turning out certain product day by day, and month by month—that in direct proportion to its efficiency and the promptness with which its results are obtained, is the value of the product—then they would realize that any facilities tending to increase the output or lessen the time required to do certain work are an economy as surely as in the case of a machine tool manufacturing material product. The difficulty of inducing managements to take this view seems to lie in the fact that the material output of the shops has a commercial value, while the equally real but less tangible product of the factory office in the nature of information and records has a value which cannot be expressed in figures, quoted on the market or listed as an asset.

Given such a wide field of operations, looked to for accurate data on so many subjects, and expected to provide and tabulate for the management such important and diversified information, it follows that the most efficient organization of a factory office and its operating along lines to secure the best results is a most serious question for the management of an industrial concern. More even than in other departments its cost is a less important question than its efficiency. Not that I would imply that it need be a costly depart-

Section	Index	Sub-Index
Metals	Steel	Tubing

No. **417** DATE, 17th March. 1902.

To **The R. JAXTON STEEL CO.**

Pittsburg.

Shipping Instructions: M. B. & Q. R. R.

30 lengths ⅜ Steel Tubing @

Form 1. CARD COPY OF STORES PURCHASE ORDER

The original is somewhat longer than the card copy, the additional space being used for the formal order and signature. The space at the extreme top bears, on the original, the firm's printed name and address.

ment, but rather emphasize the fact already stated, that its value depends entirely on its accuracy and the promptness with which its work is executed.

One of the most important functions of a factory office is acting as a bureau of information to the stores department, regarding market prices, current discounts, and the best sources of supply. In many cases circumstances are such that the purchasing can be done to greatest advantage by the store keeper instead of by agency of a distinct purchasing department. In such cases the factory office should be able to supply full information on these subjects. It should have accurate and systematic records of all quotations asked for or received by the company, and in the case of special goods being required, it is the factory office that should procure all information concerning them.

To attain these ends it should be furnished a card copy of all purchase orders issued by the stores, showing the prices and terms upon which the order has been given. By the use of carbon paper these cards may be written simultaneously with the original order. Until receipt of the goods they are kept by the factory office in a card index, arranged according to material. A reference to Form No. 1 shows that provision has been made for the clerk in charge of this index to indicate on the card the class of goods, and also the index and sub-index in which it is to be filed. This information, obtained from the body of the order, is entered on the card after it has reached the factory office. A careful use of different colored guide cards to indicate the section, index, and sub-index will result in full information regarding goods on order being instantly obtainable. In cases where the entire order cannot be written on a card, a copy of it is supplied, and the card reads: "As per copy of order herewith." This copy is then filed away in a guard book, and the page number noted on the card, which is placed in the index. The substance of any subsequent correspondence about an order or any promised date of delivery is noted on these cards, the mail being examined each day for such items. If quotations received are kept in a card index arranged on similar lines and with guide cards of colors to correspond, the factory office will be in a position to keep very close watch on the purchasing of stores. The trays for these indexes should be supplied with locked rods, permitting free examination, but preventing removal of cards by any unauthorized party. All invoices (and slips accompanying goods) received by the stores should be at once sent to the factory office after the quantities have been found correct. The factory office checks off on the card copy of order such lines as are received, remov-

Material: STEEL TUBING — Unit: Lengths

Description		JANUARY					FEBRUARY				MARCH				APRIL					
		1	8	15	22	29	5	12	19	26	5	12	19	26						
X X X	3/8																			
X X	3/8																			
X	3/8																			
X X	5/8																			

Form 2. STORES REPORT CARD

This card is ruled on the assumption weekly reports are desired—in most cases bi-monthly or even monthly would be frequent enough.

ing the card when the order is completed, and from this and the quotation cards checks the price at which the goods are billed. While the stores should of course have a free hand in the issuing of purchase orders, yet the source of supply should be chiefly determined, not by the factory office, but by the information, quotations, and records of past transactions there found.

As regards goods being manufactured in the shops for stores, the factory office should have always on hand all data regarding orders for them, their progress, quantity completed, etc. This can be done to great advantage by a card index, classified and operated on similar lines. On the factory office should be the responsibility of having such goods completed and delivered to stores without delay, also of seeing that goods ordered from suppliers are promptly forwarded. Failing receipt in either case within reasonable time, the factory office should institute inquiries and press for delivery, without waiting until the stores are completely out of the lines in question, and thus entailing vexatious and costly delays. In brief, the only transactions stores department should have with outside parties should be the actual purchasing. Other matters—obtaining quotations, watching the market for the best opportunity to purchase, inquiring concerning goods ordered, &c.—should be attended to by the factory office.

The factory office should keep close watch upon such lines of material, both purchased and manufactured, as are in most constant use. While this will be found of great advantage, care must be taken that the assumption of such duties by the factory office is not taken as lessening in the smallest degree the responsibility of the store keeper to keep proper quantities always on hand. The object is to enable the purchasing of such lines in the most suitable quantities, and at the best seasons, terms, and prices possible; also that a sufficient quantity of both rough and finished parts to provide for any probable demand for standard articles shall be always either on hand or in course of manufacture. This will necessitate close and accurate records regarding parts required for orders to assemble finished articles for stock.

The plan should only be applied to such lines as are known to be in constant and fairly regular demand. For purchased goods of this nature a card ruled as Form 2 is provided. The illustration given assumes that it is desirable to watch closely the quantity on hand, and the purchasing of certain sizes of steel tubing. On January 1st the approximate quantity in stores is filled in opposite each size, and the card filed in the factory office in a card cabinet behind a guide card

bearing date January 8th. The cards filed under current date being examined each day, it follows that on January 8th the fact that it is desirable to know the amount on hand of this line of material is automatically brought to attention. The card is sent to the stores department, and the approximate quantity in stores again noted in the column under current date. On its return to the factory office reference to the records of stores on order, together with the information on the card, will show if a purchase is advisable. The card is then filed behind a guide card bearing date January 15th. Simple as it is, this plan systematically followed up is a great assistance to the judicious purchasing of staple articles, and to the carrying on hand of the proper and most advisable quantity.

For parts for standard articles of manufacture a somewhat similar card is provided, filed according to class of goods instead of date. Instead of quantities on hand this is used to keep records of the quantity of parts, both rough and finished, for which orders to manufacture are issued, also of the quantities which will be required to provide for stock orders for assembling the complete article as these may from time to time be put in hand. It will be seen that this is very like a stock-ledger account. Instead of the quantity received and issued it shows on the one hand the quantity the shops have provided, or are providing, and on the other the quantity the shops have drawn, or will require to draw, for assembling orders. The excess one way or another will show either a surplus provision to meet demands or an excess of demands to be met for assembling orders over the provision made therefor by orders for the manufacture of the necessary parts.

A comparison of cards No. 3 and No. 4 will show on the one hand an instance in which the number of parts ordered by the stores department is growing too large, and on the other a case in which a delay in providing the stock room with the finished article requiring this part will surely occur. The figures used are purposely made to show extreme cases in order to point out more plainly the risks that can be averted by the use of this plan, namely, of accumulating too large a stock of parts, or of failing to provide the quantity needed to anticipate demands certain to be made. In the one case stores are loading up with stuff the demand for which is lessening regularly, and of which they had more than enough at stock-taking to meet all demands to date. In the other case the stores department has not attempted to provide for half the quantity required for assembling orders. Should the sales room, knowing orders are issued for a further supply

Article No. 627. Pins for 6″ Door Butts							
Orders For Manufacture		Orders Requiring		Orders For Manufacture		Orders Requiring	
Order No.	Quantity	Order No.	Quantity	Order No	Quantity	Order No.	Quantity
Inventory	300	1024	50				
617	50	1938	30				
927	50	2954	20				
1154	50						

Form 3. Stores Supply Card.

Stores are accumulating far too large a supply in view of the decreasing demand.

Article No. 627. Pins for 6″ Door Butts							
Orders For Manufacture		Orders Requiring		Orders For Manufacture		Orders Requiring	
Order No.	Quantity	Order No.	Quantity	Order No.	Quantity	Order No.	Quan:
Inventory	200	1024	200				
617	100	1938	100				
927	100	2954	200				
1154	50	3128	200				

Form 4 Stores Supply Card.

Because parts have not been actually withdrawn from stores it is concluded the supply is ample. No provision is made for demands certain to arise and which are perhaps being delayed for some good reason and in the belief that when made stores department will be able to supply them in full, without any delay.

of the finished article, let their stock run pretty low, one or two sales might wipe out the available supply, and a long delay result before further orders from customers could be filled.

To the shops the factory office stands in a dual position. To each it should represent all other shops and departments, in so far as clerical work or records are concerned. To all the shops it should represent all customers for whom work is being done or goods manufactured. It should be able on demand to inform the drawing office, assembling room, or erecting shops how many of the various parts or articles about which they may require information are either in stores, in process of manufacture, or on order for outsiders, as well as the probable date of completion, or receipt of the latter. It should always be the source of communication between the superintendent or any of the shop foremen and a customer. If the shops require details regarding work or manufacture from either the management or a customer, they should be asked for and reach them through the factory office, and should either the management or a customer make inquiries regarding any work in progress they should be addressed to and answered by the factory office.

The harm done to a manufacturing business by unauthorized promises of delivery, which invariably result from allowing customers to make inquiries direct to the foremen of the shops, is in direct proportion to the failure to fulfil such promises. Completion or delivery should never be promised unless such promises are reasonably sure to be kept. Once made, however, they should be rigorously adhered to, even at the cost of having to refuse other work. This policy may result in the loss of some orders, but the ultimate gain when it is recognized the business is being conducted on this principle will more than compensate for any failure to secure orders, or expense, or loss of a profit resulting. This statement is made altogether as an axiom of business policy, without regard to the moral side of the question.

As regards work done or material supplied on equipment, operating, or maintenance accounts—in fact on any internal or working account of the company save only those purely financial in their nature—the factory office should have as complete, accurate, and detailed records as they have regarding the manufacture of any article or execution of any contract for a customer. This result can only be obtained by enforcing an iron-clad rule that no work shall be done, expenditure incurred, or material delivered by any shop or department except upon authority of a written order, which must reach the parties or shops concerned from or through the factory office.

EDITORIAL COMMENT

THERE is a good deal of ignorance regarding the Isthmian Canal yet to be dispelled. Probably it is too much to expect the average citizen to make any intelligent study of the question, or to have any better foundation for his position than hearsay, prejudice, or the dicta of his daily paper. But it is shocking to be told that the president of the National Association of Manufacturers has taken "the position that the people really cared but little whether the Panama or the Nicaragua route should be chosen, so long as some decisive action should be taken by Congress which would advance the matter to the point of actual undertaking of the construction of an interoceanic waterway." It seems incredible, but it is officially announced as his view of the situation—and it is solely because it is official, and by implication has the influence of the Association behind it, that it is worthy of comment.

It matters but little, then, whether we choose a practical or an impracticable scheme, if only we choose quickly. It matters little whether we select a good and serviceable route or a difficult and unserviceable one, if only we "take some decisive action." It matters little whether the interoceanic waterway, if completed, will serve the commerce of the world or be a costly failure, if only we actually begin its construction. Look you, what a fine impatience is here! *Vogue la galère!* Leap before you look! Wrong or right, just go ahead! So shall the wisdom of the fathers be rewritten; but, the blind leading the blind, shall they not both fall into the Nicaraguan ditch?

IT is sometimes curious to observe how the use of a term, originally of reasonable appropriateness, within certain limitations, will become extended far beyond its original usage, and often by default be allowed an altogether meaningless application.

Thus, for example, the term "horse power," originally coined by Watt to enable a public, as yet unfamiliar with any true conception of mechanical energy, to form some idea of the capacity of his engines, is now employed to indicate what are in reality nothing more than certain arbitrary trade sizes. So far as the steam engine is concerned, the horse power, while having little or nothing to do with the power of horses, does mean a definite number of foot-pounds exerted in a given time. Engines, however, generally include the use of steam boilers, and hence the term horse power early became attached to the boiler, and ever since the beginning of steam engineering there has been discussion as to the area of heating surface, grate surface, flue section, etc., etc., corresponding to a horse power, while, strictly speaking, the term horse power in the sense of foot-pounds of energy can only be arbitrarily used at all in connection with a steam boiler.

A boiler is primarily an apparatus for the evaporation of water into steam, and while the steam is intended generally for the production of power in an engine, yet until it is so used, the apparatus in which it is generated cannot be said to have a horse power at all. A boiler should really be described by the weight of water which it is capable of

converting into steam of a given pressure, per unit of time, regardless of the use to be made of the steam after it is generated, while the economical performance should be in terms of the fuel used per unit of water evaporated, whether the steam is to be used for power, for heating, or for whatever purpose.

This term horse power is even extended to include commercial sizes of feed-water heaters, superheaters, condensers, and a number of other appliances, all used in connection with the conversion of heat into power in a more or less remote sense. All this is to be deprecated as tending to confusion between seller and purchaser, and some basis for such devices should be made, depending either upon actual dimensions or, preferably, upon the number of heat units transmitted. There is no reason why all such apparatus should not be constructed upon such a scientific basis, as regards dimensions and approximate performance, as will enable the real value to be determined by the test of dimensions, or by trial, beyond any question or controversy.

* * *

MAPS are usually fairly well understood, and within reasonable limits nearly every one is able to draw correct conclusions as to distance or direction from the ordinary charts or geographical maps available for general consultation. When large distances are under consideration, however, or when the area under discussion extends beyond ordinary limits, there is sometimes a lack of grasp which permits serious misapprehension, especially in popular articles and discussions.

Thus the usual Mercator projection, in which the world is represented upon the developed surface of a cylinder, while reasonably correct so far as the usual middle latitudes are concerned, gives very distorted ideas about routes and distances when polar regions are under consideration. In such cases it is always safe to consult a globe, as the most reliable source of information, although a good polar map, when available, will be found useful.

Thus, by taking a globe, and stretching a thread from the mouth of the Columbia river to the port of Manila, in the Philippines, it will be seen that the shortest or great-circle route passes through the Aleutian Islands, and close to the Japanese coast, leaving the Hawaiian islands far to the south. The importance of Dutch Harbor, as compared with Honolulu, is thus clearly seen, and the advantages of the northern route, with its short stretches and important commercial connections for a Pacific cable, are apparent. These features are especially interesting in connection with the leading article of the present issue, and an examination of a globe will make the importance of the Alaskan coal deposits much more readily realized.

* * *

THE visit of an earnest British economist and student of industry to this country, to prepare for an extended tour of inspection by two considerable parties representing British industrial interests, is significant of an aspect of British character which is too little appreciated by American competitors. Britain is slow to waken, but thorough when aroused. There is now working in British engineering plants a spirit and a movement of reorganization and re-equipment which is splendid in its courage and startling in its activity. The great technical schools at Manchester, Birmingham, and Sheffield are crowded to double their capacity with students—not dilettanti, but working lads, eager even after a day's work in the shops to spend the evening learning the principles of their trade. England is being modernized. Let no overconfidence lead American manufacturers to belittle her future importance as an industrial rival.

REVIEW OF THE BRITISH PRESS

Problems of Electric Railways.

THE success of the electric tramway in many parts of the world has led to the active discussion of the possibility of the replacement of steam by electric power for main line railways, and in view of the different conditions involved, the paper of Messrs. Swinburne and Cooper, recently presented before the Institution of Electrical Engineers is opportune.

As a matter of fact most of our experience in electric traction has been derived from the equipment and operation of comparatively short lines, mainly urban, in which the operative conditions are peculiar, and form no correct basis for the discussion of the equipment of main railway lines. The electric railway may and probably will come, but it will not be a sort of glorified tramway, with single, or perhaps double cars running at frequent intervals, or at sight. The problem is a different one, and should be considered on its merits.

One of the characteristic features of the urban line is the extremely varying load, involving the necessity for providing for temporary increase in capacity for certain hours. Besides this the frequent number of stops renders the question of acceleration and retardation a matter of much importance.

Regarded from the commercial side, the great cost of the permanent way and equipment of urban lines, renders the operative cost a smaller proportion of the total than is the case in main lines, and hence the greater electrical cost of rapid operation is still profitable. These questions of speed, acceleration, and retardation are examined in detail in the paper, with diagrams showing their relative importance and influence upon the entire operation of an urban electric railway.

Taking up the question of electrical pressure, and character of system, the advantages of high pressures are emphasized. The usual tramway pressure of 500 volts has the advantage of being safe, but it is more expensive than a higher pressure. So far as the element of danger is concerned, however, it can be provided for. We do not prohibit the use of locomotives because men are sometimes run over; people have learned to understand that and keep out of the way. In similar manner people will learn to keep away from electric wires, and such danger should not militate against the use of economical pressures, such as 2,000 volts. Examining the constant-pressure system used on urban tramways, it is clearly shown that, in some one of its improved forms, preferably the series constant current system, this is most suitable for such service.

Passing to main lines, the problem is seen to be radically different. Both goods and mineral traffic are to be dealt with, as well as passengers, these involving widely different speeds. Facilities for shunting have also to be provided, and sidings would introduce great complications, rendering it probably more economical to operate them by steam, or by accumulator locomotives than to include them in the main-line network.

Considering the financial side of main-line traction, it appears that the capital expenditure on existing British railways is less than one-tenth of that required for the construction of the Central London Railway per mile, so that the capital account becomes of far greater relative importance.

In considering the traffic which passes over a main line, it appears at once that it is very much smaller per mile of route than on urban lines. That is, the main lines are not worked to their full capacity as urban lines are, and cannot create traffic to the same extent. Hence the great capital outlay must be borne by a far less intensified system of operation. A comparison of operative costs shows that there is not a great opportunity for saving in electric operation over steam, although it is probable that some minor economies might be effected.

So far as increase in traffic is concerned, such an increase would probably result on the suburban portions of a main-line system, but it does not follow that there would be a large increase on main lines proper. The success of electric traction on main lines must therefore depend largely on a reduction of running cost. In other words, the question of all-over efficiency of distribution is much more important on main than on urban lines. It is wholly a financial question, and it follows that neglecting any increase in traffic, the reduction in running costs must be enough to pay for the extra capital. It is too often assumed that electric traction on main lines is necessarily advantageous, but such is not the case.

Of course it is imperative, in the first instance, that the traffic should be above a certain figure, otherwise the running costs will be increased rather than diminished.

The paper contains an interesting analysis of the relative suitability of various systems for main line traction, showing the advantages of the constant-current system. Alternating and three-phase currents are both considered unsuitable, being ill-adapted for the varying speeds and controls. Altogether it appears that the main-line problem is not yet ready for serious treatment, but that when it does come up it must be entirely upon its own requirements and conditions, and not as a development of present tramway methods.

Improvements in Passenger Steamers.

In the pressure of competition for passenger traffic on ocean steamers various lines of improvement have been followed, including not only higher speed, but also larger and more convenient rooms, saloons, smoking rooms, libraries, together with handsomer and more artistic decorations. To these have been added improved service, music, elaborate cooking, and all that can be supposed to attract the better paying class of patronage.

In this progress it has become apparent that British steamers have been surpassed by the German and French Atlantic liners, with the result that by far the larger number of passengers now crossing the Atlantic use the French and German lines, and a comparatively small proportion patronize the English boats. It was to investigate the causes of this action that a paper was presented before the North-East Coast Institution of Engineers and Shipbuilders recently by Mr. C. James, and his paper forms very interesting reading.

Mr. James first takes up the historical side of the question, showing how in the earlier steamers the first-class cabins were generally placed aft, the saloon being in the center, with the state rooms next to the ship's sides, and leading directly off the saloon. This plan was objectionable for many reasons, and gave way to the use of short alleyways between the rooms, giving entrance apart from the saloon or corridor. In the larger vessels, constructed with this arrangement the rooms are arranged in blocks of four, the inner rooms depending for light and ventilation upon hipped skylights fitted in the sides of the deck houses and casings. These inner rooms have never been popular, and are poorly lighted and ventilated.

In considering the various methods by which accommodations on passenger steamers may be rendered more comfortable and attractive Mr. James rightly believes that first attention should be given to the state rooms. Frequently too much attention is given to the arrangement of the saloons, smoke room, social halls, library, etc., and excessive expenditure lavished on their furnishings and decorations, it has been advanced that this might with advantage be curtailed, and the money be more usefully and effectively spent on the state rooms, the absurdity of luxuriating in a palatial saloon during the day only to retire to a cramped up, dark and indifferently ventilated state room at night being only too apparent. Besides this, passengers in the throes of *mal-de-mer* have perforce to spend more of their time in their cabins than in the saloons, and high art decorations, though possibly things of beauty, yield but little joy or comfort to the seasick passenger.

As a result of practical experience in steamship equipment Mr. James makes some eminently sensible suggestions. Primarily these depend upon greater liberality of space. A moderate increase in height between decks adds enormously to the comfort of passengers, and the addition of a foot or two to the length renders the berths much more comodious. Larger wardrobes should

be fitted than are usually given, and the upholstery should be portable and not covered with velvet or plush, the idea being to remove everything which could add to stiffness or the accumulation of dust.

The Bibby arrangement of "tandem" state rooms is commended, this giving the inner rooms an ell , extending to the side of the ship and providing access to a port, this rendering them more desirable than the outer rooms. State rooms fitted on the sides of the deck houses are also in much demand, and are most comfortable and convenient, especially in hot climates.

Altogether Mr. James believes that the superior attractions of the Continental lines may be met, not by the use of elaborate decorations and extravagant upholstery, but by liberality in the allotment of space, and by the most judicious use of that space for the real comfort and convenience of travellers, and in that view of the situation he will undoubtedly be joined by many travellers who cross the ocean frequently enough to prefer comfort to display.

The Magnetic Properties of Iron.

WITH the development of electric machinery it has become most necessary to obtain as full information as possible concerning the magnetic and electrical properties of the materials employed in con struction, and among these materials iron and its alloys play very important parts.

For a number of years an important series of researches has been conducted by Professor W. F. Barrett, and Mr. W. Brown, in connection with Mr. R. A. Hadfield, the well known steel manufacturer, and now we have a very interesting account of these investigations in the form of a paper presented before the Institution of Electrical Engineers by Messrs. Barrett and Brown.

In all 110 specimens were tested, these being divided into three classes, containing respectively one, two and three or more other elements alloyed with the iron. The specimens were selected from a large number as complying with the requirements as to uniformity and soundness. The test pieces were rolled into rods of circular cross section, half a centimetre in diameter and 106 centimetres long, and were tested for conductivity and magnetic permeability in the ordinary rolled, or unannealed condition, after which they were very carefully annealed and then thoroughly tested again for conductivity as well as for their various magnetic properties.

In the paper itself the results are given in detail, both in tabular form and in curves, and these must be consulted for complete information. Some of the special conclusions drawn by Professor Barrett, however, may be given here, as indicating the character and value of the work.

So far as conductivity is concerned, it appears that the conductivity of iron is in all cases diminished by alloying it with another metal, even though that metal be itself a better conductor than iron, except perhaps in the case of an alloy of iron and copper, in which the conductivity remained practically unchanged. The production of increased resistance in an alloy appears to have no connection with the conductivity of the constituents of the alloy, certainly it is not due to the greater specific resistance of the added metal.

Among the alloys of commercial value attention is called to the alloy of 25 per cent. of nickel and 5 per cent. of manganese, which has a specific resistance of 97.5 microhms and a comparatively low temperature coefficient. This is especially applicable for the construction of artificial resistances, and in this respect it resembles the alloy containing 15 per cent. of nickel and 5 per cent. of manganese, already known under the names of rheostene and resista, and used by various makers.

In examining the specific resistances of various alloys of iron Professor Barrett notices the interesting fact that the specific resistance follows the same order of increase as the specific heats of the various elements, and that the atomic weight appears to decrease as the resistance of the alloy increases. This correspondence appears to be more than a chance coincidence, and may throw some light on the obscure question as to what determines the remarkable increase of resistance in a good conductor, like aluminum, when it is alloyed with iron.

The effect of heat treatment is important in connection with the electric and magnetic properties of iron alloys. Annealing is found in all cases to diminish the specific

resistance of the alloys; and the effect varies somewhat in accordance with the degree of rapidity of cooling.

As might have been expected, the alloys of iron and nickel exhibited very interesting magnetic properties, as did also the iron manganese carbon alloys, while the already observed effect of tungsten in imparting to steel a high remanence and coercitive force was fully confirmed. Steel for permanent magnets should contain from 5 to 7 per cent. of tungsten.

Among the experiments may be noted especially the valuable alloys of iron with silicon and with aluminum. Thus the silicon iron alloy containing 2½ per cent. of silicon gives as good results as regards low hysteresis and high permeability as the best Swedish charcoal iron.

In the light of the authoritative and exhaustive investigations it should be practicable for builders of electrical machinery to secure as reliable information concerning the electrical and magnetic qualities of their materials as they have already possessed as to their strength and elasticity. There is little doubt that in future records of materials of construction their electrical and magnetic properties will be included as a matter of course in connection with the results of other physical tests, as being of equal practical value and importance.

Workshop Records.

WORKS management, and the problems growing out of it continue to attract interested attention, and among the recent contributions to this department of engineering practice we note the paper of Mr. George Parker, recently presented before the North-East Coast Institution of Engineers and Shipbuilders, discussing the existing methods of workshop records, with special reference to the use of cards and files instead of books.

After calling attention to the fact that the conservatism of British firms has led them to proceed very slowly in the adoption of the more modern methods of shop accounting and cost keeping, Mr. Parker proceeds to examine the subject at length.

So long as a firm continues to make large profits the need of efficient workshop records does not come acutely home, but as soon as competition begins to tell, and these profits decrease and perhaps disappear altogether, the question naturally arises: How and where, if possible, can the cost of production be reduced? This question, a thoroughly efficient system of workshop records alone can satisfactorily answer.

A system of workshop records should have three objective points in view, viz.:—

(1) The tracking of the state of progress and cost of products through the factory;

(2) The lessening of the costs of production; and

(3) The determination of a price at which the factory products may safely be offered on the market;

And in order that these may be accurately arrived at the following records must be kept:—

(1) Records of orders for work to be done;

(2) Records of labour or work done;

(3) Records of material, raw, in progress, and finished; and

(4) Records of establishment charges.

Each of these latter groups of records Mr. Parker examines in detail, showing their relative importance, and the most satisfactory manner in which they may be executed.

The records of orders, under the older methods were kept in a number of books, accessible only to the manager and his clerk, but under the more modern system all these records are kept on cards, which are filed systematically in such a manner that they may be collected with the other records when the work is completed. Labour records formerly kept by the cumbrous system of time checks, are now kept partly by machinery, as regards the time of arrival at and departure from work, and partly by job order or piece order cards, following the work through the shop and forming, when complete, a portion of the whole records of the work.

Records of material involve the keeping of a rough store and a finished store, distinct accounts being kept with each of these exactly as if they were independent establishments from which material was being bought and to which finished goods were being sold except that the records are kept in terms of quantity instead of price.

The question of establishment charges is one concerning which much has been writ-

ten and in which there is a great variety of practice. The old method of charging everything which could not be charged directly to orders to an establishment charges account, and then dividing this up among all the productive orders according to some percentage system is now replaced, in many works, by a list of different headings under which everything is charged that can properly be separated as belonging to different orders.

There are, however, many other items coming under the heading of establishment charges which are only obtainable from the commercial books, such as rent, rates, taxes, office expenses, etc.; or arrived at in an arbitrary manner, like depreciation. In some businesses it is also advisable to keep the selling expenses entirely separate from the working expenses, especially where a firm manufactures largely for stock and is in fact a dealer in, as well as a manufacturer of, its products.

The subject of depreciation is so important that it would require a separate paper of itself in order that full justice should be done to it; for on the manner in which it is treated very often depends the success or failure of a business. All firms recognise that depreciation must be provided for, but very few agree as to the amount which is necessary to cover it, or as to the manner in which it is to be computed.

Taking into account all the various details of establishment charges there is no reason why the question of oncost should not be charged in an equitable manner to the product at each stage of its manufacture. There are many different methods of determining oncost, but they all belong to one or other of three classes.

1.—By a percentage on direct or productive labour, based on past or current records.

This is the method in most general use in this country, although owing to its overburdening highly-paid skilled labour and under-burdening cheap unskilled labour it gives in many cases far from reliable results. This disability may be somewhat minimised by adopting a different percentage for each class of work.

2.—By an hour rate based on the average number of hours of productive labour.

This is the method usually adopted in America, and except in shops where there is a great diversity in the size and cost of individual tools it will be found to give very reliable results, the loss incurred on cheap labour as in the "percentage method" not having to be made good at the expense of work requiring dearer labour but less time. Some accountants and managers recommend that this rate should be recalculated every month, but this will generally be found to give more trouble than it is worth. Probably the best method of varying this rate is by a sliding scale based on the average number of men in productive work. This plan is used in several American shops, the foreman's time-stamp being utilised to stamp the job cards with the number of men in productive work each day.

3.—By a machine hour rate, supplemented by an overhead hour rate for those charges which it is impossible to allocate to the machines.

This is far and away the most scientific method, for it enables the machinery used to be taken into account in costing work, and this is a most important advantage, especially now that machinery is becoming to be more and more used in every branch of industry. Many will object to this method as involving too many complications, and except in shops where there are both very large and very small machines it may hardly repay the trouble of installing it, although on the other hand the information afforded will be an undoubted advantage.

The Protection of Workmen.

With the increasing use of machinery in all departments of industry, and the employment of less skilled operatives in attendance it has become more and more important that the probability of accidents shall be reduced to a minimum. In this connection the papers presented at a recent meeting of the Institution of Mechanical Engineers are of interest, and treating of a common subject in general, they may well be noticed together. The papers referred to are those of Mr. W. H. Johnson, on the guarding of machine tools; of Mr. Henry D. Marshall, on the fencing of steam and gas engines; of Mr. Henry C. Walker, on the protection of lift shafts; and of Mr. Samuel R. Platt, on textile machinery.

The conditions of a perfect guard are enumerated by Mr. Johnson as follows:

1st. It must fence the tool efficiently; in other words, it must protect workmen from all dangerous moving parts of the machine, and thus satisfy the factory inspector.

2nd. If possible it must be attached to or near the tool, as if loose a careless workman will remove it and not replace it, so that it ceases to act as a guard.

3rd. At the same time it must be so constructed that a workman can move it on one side to oil the machine, adjust a belt or change wheels and bring it back into position with a minimum of time and trouble.

4th. While sufficiently strong it must not be heavy or clumsy.

5th. The guard must not prevent the operator seeing through it unless it is intended to act as a cover to keep chips of metal out.

In examining detailed examples of guards for different kinds of tools, Mr. Johnson naturally calls attention first to the housing of gear wheels, this protection now being generally provided by the builders. Small gear trains may readily be housed with cast-iron covers, but for large gears light and effective coverings may be made of planished sheet iron. In most other cases the dangerous parts of machine tools are best guarded by frameworks of wire netting, but such nettings should be constructed in accordance with the experience of the users of the tools, and not left to the untrained judgment of the wire worker. In regards to the protection of circular saws shown by Mr. Johnson, it appears to guard as well as practicable against the accidental cutting of the workman, but it should be remembered that a very frequent cause of serious accidents with circular saws is that of the catching of pieces of wood in the teeth of the saw just as the cut is finished, the loose block in such cases being thrown violently back over the saw against the operative, striking him in the head, often with fatal consequences. A heavy plank, hinged from the ceiling and hanging low enough to protect the man without obstructing his vision of the work, forms an effective guard.

The guarding of steam and gas engines, discussed by Mr. Marshall, is one which has been considered for a long time, and in well appointed establishments is generally well effected. Engine rooms should be so arranged that no operatives need pass into or through them, so that the chief protection needed is that for the actual attendants. Apart from the provision of a rail or screen about the crank and connecting rod, the principal points requiring attention are the provision for lubricating the moving parts, and the arrangement of suitable safety starting gear. Mention should have been made ot the high degree of safety attained by the various forms of enclosed engine, such as the Willans & Robinson, the Westinghouse, and others, no moving parts appearing except the fly wheel and belt pulley, and all lubrication being effected automatically. This form of design is also well adapted to gas engines.

Accidents with lifts are usually due to leaving the doors open or by starting the car while people are entering or leaving, and hence nearly all safety appliances involve some interlocking device by which the door cannot be opened except when the car is at its exact level, and by which the car cannot be started until the door is closed. To these may be added the various forms of automatic platform gates, which close the shaft at every floor except during the passage of the car, these effectually preventing a fall of more than one floor in any case. Accidents with lifts are exceedingly few, and with reasonable care may be guarded against very successfully.

Textile machinery contains numerous opportunities for possible accidents, but present designs include good protection against injury to the attendants.

It has been found by experience that the operatives themselves are not favourable to the use of guards over the moving parts of machines, and hence it is necessary to construct the shields so that they cannot be readily removed. Indeed the introduction of fully guarded machinery does not altogether meet with the approbation of mill-owners, as so much guarding involves additions to the cost of the plant without increasing the efficiency of the machinery. The liability of employers in case of accident from imperfectly protected machinery, however, renders neglect in this respect an expensive matter in case of injury.

REVIEW OF THE CONTINENTAL PRESS

Maritime Aeronautics.

THE subject of aeronautics continues to occupy the attention of engineers, especially in France as is indicated by the various articles in the technical journals and transactions of societies. The eminently practical nature of such papers shows that the matter is being considered in the same manner as any other mechanical problem, with a view to its working utility as soon as practicable. We notice especially a paper presented before the Société des ingénieurs Civils de France by M. E. Surcouf, upon maritime aeronautics, and also a general review of the recent progress of aeronautics, by M. G. Espitallier in *Le Génie Civil*.

The practical nature of the present investigations is shown by the modifications which have been made in the problem over the efforts of earlier experimenters. Formerly the idea of the early aeronauts was to see how high they could go, and visions of balloons far aloft, sailing from one distant point to another, filled the minds of inventors. Now it is recognized that the real advantage of aerial navigation lies mainly in the avoidance of terrestrial irregularities, and that in most cases it is only desirable to ascend high enough to obtain a clear path. Indeed some sort of communication with the surface is found very desirable, especially in the efforts to secure dirigibility and stability.

Apart from the great question of supporting sufficient motive power to progress against the wind, the two great problems in practical aeronautics are those of securing definite stability, and of controlling the direction of navigation.

One of the greatest obstacles to stability lies in the shifting of the centre of pressure in a balloon which is partially filled with gas. If the bag is not fully inflated the slightest variation of position, especially in the modern cigar-shaped balloon, causes a change in the position of the mass of gas, and the consequent shifting of the centre of pressure. This difficulty has been largely obviated by the use of the so-called internal "ballonet," which, being inflated with air, keeps the outer balloon distended and taut when a portion of the gas has been discharged. This device, due to Dupuy de Lôme, has done much to improve the stability. The experiments of Renard have also shown that the stability may be increased by making the greatest diameter of the balloon one-fourth of its length distant from the forward end.

The greatest aid to stability, however, is the guide rope, first practically employed by the English aeronaut Green. This has been employed to advantage by Santos-Dumont, and was the principal reliance of the ill-fated Andrée and his companions.

Naturally any device of this sort is impeded in its usefulness by the irregularities of the earth's surface, but in a modified form it has been found most serviceable over bodies of water. As M. Surcouf points out, aerial navigation over water, or maritime ballooning as it may be termed, possesses numerous advantages, which he examines at length.

Maritime ballooning was first investigated scientifically by Hervé who, in 1885, studied the effects of moderate floating resistances, and made a number of experiments over the lake of Geneva. In subsequent investigations Hervé has elaborated this idea, until at the present time he has developed what may be termed a system of maritime ballooning of much interest.

Hervé found that a single guide rope, or trailer, while adding materially to the stability, did not fully meet the requirements, and for ballooning over bodies of water, he conceived the idea that the presence of the water might be made a very efficient aid in the management of the balloon. His method consists in the use of two trailers, one, provided with a form of sea-anchor or bucket, trailing out behind the path of the balloon at a low angle, about 22° from the horizon-

tal; the other hanging as nearly vertical as can be practically accomplished. The two trailers thus form a sort of triangular frame with the surface of the water, the balloon being attached to the upper acute angle. The second trailer, instead of carrying a drag anchor, is provided with an articulated float, consisting of a number of blocks of wood in the form of a sort of chain which will float upon the surface of the water, or which may be partially or wholly lifted into the air.

This combination provides a means of correcting for several varying conditions otherwise most difficult to control. The drag rope and bucket maintains the car of the balloon in a stable position, and effectually prevents the dangerous oscillations otherwise caused by every puff of wind. The second, or equilibrium rope adds to the steadying effect, and also provides the long sought compensation for variations in weight.

The great variables in ballooning are snow, hoar frost, and rain. On a large balloon, such as the "Mediterranean" a heavy rain may increase the weight more than 200 kilogrammes, while a rapid evaporation may produce an equal negative effect. Similar effects are produced by snow and frost, and these have always been difficult to provide against. The equilibrium float furnishes a means of varying the ballast, since the very considerable weight of the float may all be thrown upon the balloon simply by lifting it from the surface of the water, while the contrary effect may be produced to any degree by permitting a portion or the whole of it to rest upon the water. By drawing the equilibrium float from the water, the balloon may be caused to descend so that a boat may be lowered or a vessel boarded, after which the float may be lowered and the balloon permitted to ascend.

The use of the triangular system of guide ropes adds to the stability to such a degree that serious attempts may be made to utilise the action of the wind as a propulsive force, their influence being similar to the keel or centre-board of a yacht. This action is greatly assisted by the substitution of a special form of drag to the guide rope, instead of the simple bucket. By employing a drag composed of a number of long plane or curved surfaces attached to two guide ropes, the desired steering capacity is effectively provided, and thus the balloon over the sea is equipped with all the elements for successful sailing.

M. Surcouf discusses the applications of these appliances both to spherical balloons and also to the constructions of M. Santos Dumont, and describes at length the very interesting experiments of M. Hervé, the whole forming a valuable contribution to the increasing literature of modern aeronautics.

Experiments With Electric Boats.

THE trials which have hitherto been made of electrically propelled launches and boats have generally not been in such a shape as to render them comparable with tests of other vessels, and hence the trials discussed in a recent article by Professor Oswald Flamm, and published in *Schiffbau*, demand notice and comment.

It was intended to make extended trials of an electric boat of 16 metres length in order to obtain data as to speed and powering, and before proceeding with the construction two models, one-tenth of the size of the completed boat were prepared, and given thorough trials in the testing tank of the North German Lloyds at Bremerhaven to determine their resistance and behaviour at various speeds. Professor Flamm gives the results of these tank trials at some length, analysing the resistances so far as their separation into wave-making and frictional resistance is concerned and showing the effect of the modifications in the lines of the model. Some very interesting photographs show the influence of speed and form upon the waves made by the models when under trial in the testing tank.

The results of the trials was the adoption of a model slightly differing from either as the form of the boat actually constructed and hence the result of the actual tests are not as strictly comparable with the model experiments as would have been the case had the lines of either model been followed absolutely.

The completed boat was 16 metres long, 2.50 metres in width, and 0.80 metre depth amidships, with a displacement of 17.20 cubic metres.

The weight of the motor, accumulator, switches, and conductors made 11.049 kilo-

grammes, or for 60 h. p., about 185 kilogrammes per motor horse power. This is so greatly in excess of that required for steam or internal-combustion motors as to call instant attention to the field for improvement in the reduction of weight.

The trials of the boat, in which the speed was determined by the corrected readings of several mechanical logs, are given both in tabular form, and as curves, and may be compared to advantage with the records of the tank trials, although, as before noted, the modifications in the model render precise comparison impracticable.

At a speed of 10 knots the power required was 59.30 h. p., at 7.70 knots, 18.10 h. p., and at 4.90 knots, 5.30 h. p. At the speed of 10 knots the radius of action was 30 sea miles, while at 4.90 knots this was extended to 220 sea miles.

Further trials are to be made, but with the data and results already given by Professor Flamm much valuable information as to capacity and cost of electrically propelled boats is given.

The Strength of Spherical Lids.

Some time age we noticed the exhaustive experiments carried on by Professor Bach at Stuttgart, upon the deflection and resistance of flat lids on cylinders subjected to internal pressure. He has now extended these experiments to include hemispherical concave lids, and in view of the extensive use of similar constructions in actual work, his researches possess much practical value.

From a detailed account in the *Zeitschrift des Vereines Deutscher Ingenieure* we make a brief abstract of the account of the experiments, referring the interested reader to the original for fuller details.

As in the case of flat lids, the important information desired in practical service relates rather to the deflection, or gradual yielding, than to the ultimate resistance to rupture, and hence the apparatus was arranged to furnish quantitative measurements of the yielding at various portions of the surface under different pressures. The head under test was riveted into a short and heavy cylinder, closed at the bottom, and arranged so that it could be completely filled with water, and subjected to internal hydraulic pressure. Over the top of the cylinder was placed a rigid frame work pierced with holes through which a number of gauge rods passed, resting freely on the surface of the lid under test. The tops of these rods were all brought to a level before the pressure was applied, and subsequent micrometer measurements showed very precisely the changes occurring at various places on the head.

The experiments were made with heads of copper and also of low steel, 700 mm. in diameter, the tests being made with hydraulic pressures up to 70 atmospheres, or about 1,000 pounds per square inch. The results are plotted in the form of curves, and also reduced to tables, and in general they show that there is very little yielding over the entire surface, until at some limited area there is a sudden reversal of curvature, after which the head becomes entirely reversed as the pressure is increased..

The especial designs under test were intended for the double bottoms of brewery kettles, in which steam is admitted in the space between the two bottoms to heat the liquid. For this purpose it is necessary that the joint should be properly designed, so that the action of the pressure upon the material in actual service shall not be different from that obtaining when under test. Details of suitable joints are given by Professor Bach, and the whole subject is treated in an eminently practical manner.

In thus conducting laboratory tests so as to provide accurate quantitative results upon constructions used in actual practice Professor Bach has set an admirable example for work in mechanical laboratories elsewhere, and a study of his methods will be found valuable to instructors and practicing engineers alike.

Travelling Sidewalks.

Those who observed the very satisfactory operation of the overhead travelling sidewalk at the Paris Exposition of 1900 have doubtless wondered that some permanent installation of such a convenient system of transport has not been made since that time. Naturally such a system does not equal in speed the fast-running electric street railway cars, but the carrying capacity of the travelling sidewalk is immense, and the time saved by the fact that

no waiting is required largely makes up for the slower running speed. Especially does the continuous movement render the system applicable to the relief of the congestion at certain centres of traffic, where the main demand is for the transport of great numbers of people, during rush hours of the day, through comparatively short but contracted thoroughfares.

Several years ago an interesting historical paper upon the subject was read before the Société des Ingénieurs Civils de France by M. Armengaud, Jeune, discussing the earlier devices, and describing in detail the travelling sidewalk of the exposition, and now we have a paper before the same society, by M. D. A. Casalonga, emphasising the advantages of the traveling platform, and submitting a plan for such a structure running from the Place de la Concorde to the Place de la Bastille, following the lines of the Grands Boulevards and running in a subway beneath the streets.

The installation of the travelling platform at the exposition of 1900 was overhead, and was 3.4 kilometres in length (2.11 miles), while the plan of M. Casalonga contemplates the distance from the Place de la Concorde to the Bastille and return, making a loop at each end, with a total length of about 10 kilometres, (6.21 miles), the platform running entirely in a subway.

In its general construction the platform suggested by M. Casalonga does not differ materially from that of MM. Blot, Guyenet and de Mocomblé at the exposition, except that he proposes to use three moving platforms in addition to the stationary one, thus obtaining speeds of 4, 8, and 12 kilometres per hour, while he states that with four platforms a maximum speed of 22 kilometres may be conveniently attained, or about 13½ miles. Instead of arranging the platform as a circuit of a given area, moving continually in one direction, the proposed scheme involves a double platform, forming really one continuous structure, running under the so-called Grands Boulevards in both directions, there being loops at the Place de la Concorde and at the Bastille, as already mentioned. By providing cross-overs at the various stations it would be possible for a passenger to travel in either direction for any desired distance and then leave the platform for the returning side. The plan involves a double tunnel of rectangular section, as near the surface as possible, in order to avoid unnecessary stair climbing, and the details appear to be very well worked out.

Whether this ambitious scheme is carried out or not, it calls renewed attention to the capacity and capabilities of the travelling sidewalk as a means of conveyance. Even without resorting to such an extensive application, there are numerous locations in which it might be installed to great advantage. Its chief value appears in the continuous manner in which it acts. Crowds are mainly caused by the intermittent nature of other methods of transport, and in the hurried morning and evening hours the closest practicable headway of trains or trams leaves intervals for crowds to form and become difficult to handle. The continuous travelling platform takes the stream of people as they arrive, thus preventing most effectually any accumulation, and this is the main secret of its applicability. Among the locations where such a system might be readily and conveniently applied are the platforms of railway stations, long piers at steamship landings, and especially the crowded sidewalks of certain bridges. Thus the travelling platform has been suggested as a means of relieving the congestion of the Brooklyn Bridge, New York, for which it appears to be eminently adapted, and indeed there is every reason why the installation of such sidewalks should be contemplated in the construction of all such large and important bridges, even if they are not necessary at first, since the subsequent work might be readily done at a later date if provision were made in the original design.

The travelling platform appears to be the logical evolution of efforts to provide for continually increasing traffic. When the separate train or tram service is first installed the trips are few and far between; as the numbers of passengers increase, the headway is reduced and the cars follow each other closer and closer; so that the introduction of the moving platform is really the merging of separate trains into one great train, covering the entire road-

way, and rendered capable of ascent or descent without interruption of motion.

It was Pascal who first defined a river as a travelling highway, and possibly the flow of the river may be repeated in the mechanical stream of the travelling roadway as the solution of a problem in transport which has become perplexingly difficult in many places.

High Pressure Centrifugal Pumps.

THE application of centrifugal force for the impelling of gases and liquids has resulted in the production of some very ingenious devices, of which the most important are fans and pumps. As ordinarily constructed, however, such apparatus is limited, especially as regards the pressures against which it can be operated. Fans are therefore usually employed for moving large volumes of air at comparatively low pressures, generally below 24 inches of water, while centrifugal pumps rarely are required to force water against more than 50 feet head.

In a recent paper published in *Le Génie Civil*, M. Rateau, well known for his experience in this class of machinery, discusses the conditions which will enable such machines to act against much higher pressures than hitherto, and as the matter is one of more than ordinary interest, some abstract of his results is here given.

There are two methods of enabling a fan or centrifugal pump to operate against a high pressure, either by increasing its rotative speed, or by arranging several fans in series so as to obtain their cumulative effect. M. Rateau discusses both methods, and describes his experimental tests. For fan blowers the increase in rotative speed is found satisfactory, especially as it has become possible to utilize in this manner the high rotative speed of the steam turbine as a direct-connected motor.

For this purpose M. Rateau constructed a direct-connected set consisting of a steam turbine on the principle of the Pelton wheel and a 10 inch fan, and conducted a careful series of experiments to determine the effect of operation at different high speeds. The experiments, for the full data and results of which the reader must be referred to the original paper, showed that the pressure as indicated on the water gauge varied nearly as the square of the speed. Thus at 10,500 revolutions a water pressure of 4.56 feet was sustained, while at 20,200 revolutions the pressure reached 18 feet. Such pressures enable the centrifugal fan to be used for blast furnaces and for Bessemer converters, applications which have hitherto been found practicable only for blowing engines of far greater cost and bulk.

Especially important is this fact, since it removes for such work the chief disability of the steam turbine, its high rotative speed. Gearing is always objectionable, especially when operated at high speeds, but gearing has been found necessary for the reduction of the speeds of the steam turbine, to enable it to be used even for driving electric generators. For high-speed fans, however, the direct combination of steam turbine and fan appears to be altogether satisfactory, and it should come into extensive use.

In pumping water such high rotative speeds can not always be used, but by the employment of electric motors centrifugal pumps have been operated successfully at speeds of more than 2,200 revolutions, for a wheel of 8.2 inches in diameter, against heads of about 100 feet of water. By combining such pumps in series, the wheels all being upon one axis, and each feeding the water to the next, the water can be forced against much higher heads. Thus with five wheels 10.6 inches in diameter (270 mm.) running at about 1,200 revolutions, water was forced against a head of 200 to 250 feet, with a pump efficiency of nearly 70 per cent.; while with seven such wheels a head of about 325 feet was overcome, with about the same efficiency.

In order to experiment with still higher speeds, M. Rateau constructed a pump of only about three inches in diameter (80 mm.), and operated it, by means of a steam turbine, at speeds from 9,000 to 18,000 revolutions per minute. At 9,000 revolutions this little pump overcame a head of about 230 feet (70 metres), and at 18,000 revolutions the pressure head was equal to nearly 1,000 feet (300 metres), so that the rate of the square of the velocity was practically maintained.

M. Rateau discusses his apparatus and results in detail, giving curves showing the pressure, volumes and efficiencies during the

tests, and the whole forms an admirable example of scientific laboratory work, as might be expected from an expert of his standing.

These interesting results appear to open up a little-worked line of engineering practice, for although fans and centrifugal pumps have been in use for a long time, and have been most thoroughly investigated within certain limits, it now appears that those limits may be greatly extended to much advantage. The extreme simplicity of the centrifugal pump, and its ready connection with the equally simple steam turbine, at once places in the hands of the engineer a combination offering many and important applications. The centrifugal pump is no longer limited to the handling of large volumes of water alone, but may be used for deep mine lifts, for municipal water supply, for fire extinction, and even for boiler feeding.

The Trolley Omnibus.

THE application of electric traction to common road vehicles has been impeded by the difficulties in connection with the use of storage batteries, especially as to the weight to be carried. One solution of the question has been found in the use of overhead trolley wires to convey the current from a generating station to the vehicles, and from an account in a recent issue of *La Revue Technique* we abstract some account of successful experiments with the trolley omnibus in France.

The Lombard-Gérin system was shown at the Vincennes annex at the exposition of 1900, and has been in practical service at several places since, notably between Fontainebleau and Samois. The idea is to avoid the necessity of constructing any special track, and hence the feature to be secured was the maintenance of communication between the omnibus and the trolley wires, and at the same time permit entire freedom of the road to the vehicle.

Since there can be no rail for the return current, two trolley wires are necessary, and the first attempts were made with a trailing trolley, running upon the wires, and provided with sufficient length of cord and conductors to permit the omnibus to turn to any part of the road. This was found impracticable in service, as might have been expected, the trolley frequently becoming caught and entangled, interrupting travel and rendering accidents imminent.

In order to avoid these difficulties the Lombard-Gérin system provides the trolley with a small motor of its own, which causes it to travel upon the wires in advance of the vehicle, there being always sufficient slack in the connecting wires to leave the omnibus free space for manœuvring. The details by which this arrangement is carried out are ingenious. The omnibus is provided with its own continuous-current motor, taking its current from the trolley wires overhead in the same manner as an ordinary electric tram. Besides its function as a direct-current motor, this is also a rotary transformer, producing a three-phase current, which operates a small three-phase motor in the trolley. By this ingenious arrangement the trolley motor is made to vary its speed just as the speed of the vehicle is varied, and hence the trolley always keeps in advance of the omnibus, advancing and stopping in accordance with the motion of the main motor. The total weight of this automobile trolley is about 20 kilogrammes, and it is readily carried upon the conducting wires.

The line between Fontainebleau and Samois has been in operation long enough to enable some data as to expense of exploitation to be determined. The length of the route is 5 kilometres and the time required per trip is 20 minutes. With a fare of 40 centimes the ratio of receipts to expenses was 58 per cent., and for short distances, where the traffic is not sufficient to warrant the expense of the construction of an electric tramway line, the system may find satisfactory application.

While it is not to be expected that any omnibus system can exist in competition with electric tramway traction there is an intermediate stage in which it may find useful application. This is the case in the replacement of animal traction for roads where the electric railway will ultimately be introduced, but where the immediate demand is insufficient. Also for connecting small resorts and country towns with railway stations, or for the hauling from manufactories to shipping points. In such locations the highway trolley system will doubtless find useful applications, and in many cases build up an important traffic.

REVIEW OF THE AMERICAN PRESS

Reciprocity and Manufacturing.

THE development of export trade in American manufactures and especially in American machinery, together with the significant emphasis laid upon reciprocity by President McKinley in his last speech, has impelled the *American Machinist* to investigate the present opinions of leading manufacturers upon the question of foreign trade relations. From a number of replies received in response to a circular letter, some most interesting and valuable deductions may be drawn.

In the first place, out of 58 replies, there were 45 which endorsed the famous passage from Mr. McKinley's speech, while no disapproving responses were received. A great majority of the replies showed that the American machine manufacturers realize that they need no tariff on their productions, and would prefer to see the existing tariff reduced or abolished, believing it to interfere with foreign trade. As one manufacturer significantly expressed it: the only protection needed is that already furnished by the patent laws.

When it is considered that these replies represented establishments having more than $35,000,000 capital, and employing more than 22,000 workmen, it will be seen that the protection sentiment is hardly as strong as it formerly was in American industrial circles.

The fact appears to be that American manufacturers have accepted the view of the late President Garfield in considering protection merely as means toward ultimate free trade, and finding themselves in a position in which they have no possible apprehensions of serious competition from European manufacturers, desire to further trade with all the world to the utmost possible extent.

Whatever may have been the theoretical views of the writers of the letters which the *American Machinist* has so effectively gathered and made public, there is no doubt that the views now expressed are those showing their own immediate business relations. It is the effect which they feel will be produced upon their own trade which impels them to write as they have done, and the opinions are all the more weighty on that account. They realize that a nation cannot always sell and never buy, and they know that their own export trade largely depends upon the opportunity of their customers to sell to them.

The publication of these letters shows that the protection sentiment in manufacturers can no longer be appealed to by politicians upon the old argument that it is necessary to prevent the product of European cheap labor from entering into competition.

As a matter of fact the whole question of modern manufacturing no longer depends upon the employment of cheap labor in the sense of hiring workmen at low wages. Modern methods involve the attainment of economy by the employment of far fewer men, of high attainments, receiving high wages, and directing the vastly increased output of improved machinery. Such methods have nothing to fear from foreign competition, and need no protective tariffs, as the manufacturers have already found out. The wise politician will not be long in discovering the changed relations brought about by the transformation in modern engineering methods, and if he cannot adapt himself to the changed conditions it is not the manufacturers who will have cause for regret.

Foundry Economy.

IT is only within quite recent years that the foundry has received its fair proportion of attention as a department of shop administration and economy, although there are few departments which bear as important a relation to the efficiency of an establishment as a whole. The American Foundrymen's Association, how-

ever, has done excellent work in raising the standard of the department of mechanical engineering to which it relates, and many of the papers of its members contain valuable matter.

In a recent contribution to the *Journal of the American Foundrymen's Association*, Dr. Richard Moldenke discusses the various methods by which better economy may be attained in the foundry, so that a fair profit may be made, even in the face of the continually falling price of castings. Briefly, as he well says, the solution of the question will be found in the introduction of a good cost system in the office and the use of scientific methods, where needed, in the works. The paper devotes itself to the discussion of the latter portion of the problem.

Scientific methods may usually be more readily introduced in the large foundry than in the smaller establishment, and the small founder must adopt his own methods, the results of his own observations to obtain the best results.

"The most important consideration is naturally the daily product. This must be kept up to standard, and at the same time be as low in cost as possible. Here is where the cost accounts come in. One must know the cost per pound of the good castings sold for every department in the establishment. Thus if the cost of core-making runs say 0.25 cents per pound in one month, and it creeps up gradually to 0.35 cents in the course of the next three, it is time to see if the knife cannot be applied effectively, or failing this, to re-arrange or place new machinery to get the work out to better advantage. On the whole it will pay to do the latter anyway, for until the monthly figures are not brought down to a point where there will be only a fluctuation of a few points, the department cannot be said to be in proper working order. Be it understood that this refers to a fairly uniform run of work. The principle involved, however, is a truly scientific one and should be applied in every manufacturing establishment.

The molding machine question will be found the most important one so far as the foundry pay-roll is concerned. A well-managed pattern shop and pattern storage system are also money savers. If the founder is personally systematic in his work, he will not tolerate slip-shod habits in his employees; if he is not inclined that way, it were better for him to get an associate who is systematic. Then should come the establishment of systems of working marked by extreme simplicity and carried through with an iron hand, the head of the establishment setting the example."

Dr. Moldenke gives some excellent advice about the maintenance of his stock of material in a state from which he can produce the quality of castings demanded by his trade at will. The maintenance of separate and carefully recorded piles for the various brands of pig iron is urged, as well as an intelligent classification of the scrap, both domestic and foreign. This will enable the foundryman to compare his charges with his product, and by cutting out the suspected brands in case of trouble, he may establish his own mixtures with reasonable satisfaction. His words on the subject of the employment of a chemist are suggestive in this connection.

"What is needed to make this work on mixture-making successful? Simply a knowledge of what is in your pig iron and what is in your own scrap. Even this can be narrowed down to the silicon in both items for the daily run of work. I will go even further and say that two or three determinations of silicon a week, together with stocks of irons, well sampled and analysed as they are bought, and an occasional sulphur determination of your coke, is all that the jobbing or stove founder requires. I know cases where this work amounts to less than six dollars a week, or not even the wages of a laborer. I feel quite certain that many a young chemist would be glad to locate in a foundry if he can get that much from three or four foundries to begin with."

So far as operation is concerned, the main thing is to maintain control of your own establishment. It will not do to permit the cupola tender to assume that he knows it all, and that no one may share his knowledge, lest he becomes no longer indispensable. Systematic mixtures, careful weighing of charges, and ordinary intelligence, watched over by foreman and owner, will give reliable results and render the foundryman independent of any individual employee.

"With the purchase of pig iron under

chemical specifications, a good method of making mixtures which can be depended upon to produce the results desired, and the proper disposition of the charges in the cupola, the good that science can do the founder is accomplished in the main. There are of course many points which a well managed laboratory can place on an economical footing, especially when we turn to furnace irons, and special line of castings. For the owner of a foundry which turns out say ten tons of castings every other day, it would, however, be unwise to establish this department as an adjunct to his works. He does better by sending his work out and learns all he can to apply the reports he gets properly.

"Let it be understood that a good mixture mismanaged will give poor castings, but a poor one cannot under any circumstances turn out good work. The sole object of all this scientific manipulation is to start you off right, and then you must follow it up with due vigilance through every department of your work."

The Action of Curved Jetties.

We have already referred in these columns to the principle of the curved reaction break-water of Professor Haupt, and discusses its effects in the incomplete structure at Aransas Pass, Texas. We now have a paper by Professor Haupt, in the *Journal of the Franklin Institute,* discussing the relative action of straight and curved jetties, and showing very clearly the manner in which the latter form acts.

As has already been noticed in connection with the methods of river regulation advocated by Timonoff in Russia, and by Girardon in France, it is becoming understood that the best plan is to control a stream in the course which it has marked out for itself, rather than to attempt to compel it to follow an arbitrary straight course. This point is well brought out by Professor Haupt.

"No stream pursues a straight course if it can possibly avoid it, but swings gracefuly from side to side, cutting first on the right then on the left, but always on the concave bank, and depositing on the elbows and crossings or points of inversion. Neither do the filaments of the stream pursue parallel paths. The maximum velocity is found near ıe mid-area of the section, but if these particular particles were to continue uninterruptedly along this course of maximum velocity they would run away from the rest of the water and leave a void. This tendency is checked by a constant interchange of position of the particles which restores the equilibrium by swirls and eddies, cross, and even back currents, in certain sections. It not infrequently happens that water runs up hill, as in the case of a flood when the crest of the wave gives a reverse slope up stream. Such are few of the phenomena of flowing bodies, which are well recognized and understood by navigators or others who are familiar with streams flowing between banks; and precisely the same conditions characterize streams in the ocean or other large bodies of water."

These principles have been known and understood for a long time, both by engineers and navigators. Extracts from the writings of such well-known authorities as Wheeler, Scott-Russel, Fontain, and others show that straight reaches are considered unadvisable in the planning of river improvements, and every river pilot knows that the deep channel is to be found close under the concave side of a bend, and that the sharper the bend, the deeper the channel.

At the same time these principles are so frequently violated in actual practice that there is reason for emphasizing them and showing the true extent of their application. It will not always do to apply mathematical principles arbitrarily to physical problems, and while a straight line is the shortest distance between two points it does not follow that it is the best for to apply to a navigable channel. As Professor Haupt says:

"The concave bank practically controls and directs the stream—it is the point of attack for the currents and the point where scour is most rapid. The convex bank is the reciprocal of that where there is virtually no current and where deposit takes place. The continuous change of direction caused by the resistance or reaction of the concave bank, and the consequent differences of velocity of the fluid-particles before and after impart, cause a lateral bottom movement which carries the silt across

and on to the convex bank, thus maintaining a deep channel under the concave bend; the depth increasing with the sharpness of the turn.

"By maintaining these oscillations by the erection of artificial banks or reaction-jetties across ocean bars the channel may be quickly and cheaply created by natural processes; but great care must be taken in adjusting their curvature and location to the requirements of the particular site, for if placed on the wrong side of the channel with respect to the littoral drift at inlets, they will result in failure.

"Thus a single structure may be made to produce its counterpart, or convex training-bank, which will be automatically adjusted to the regimen of the currents, whether tidal or fluvial, at less than half the cost of the parallel straight jetties, and give a far better and more permanent result, requiring a much smaller expenditure for maintenance."

Machinery at the Wachusett Dam.

It was at the construction of the Chicago drainage canal that the greatest demonstration in recent times was made as to the economy due to the use of machinery for excavating and handling material, and in a somewhat different manner we have a similar demonstration in the use of machinery in the construction of the great Wachusett dam at Clinton, Mass. From an account of the works in a recent issue of the *Engineering Record* we abstract a portion relating to the mechanical appliances there in use.

The most important features in this equipment are two rope cableways, extending across the valley on the line of the dam, and used for handling the excavation, removing the spoil, and delivering the materials for the masonry. The cableways are of 1,155 feet span, and of 9 tons capacity, and in connection with the railway they have no difficulty in handling all the material.

The power for these and for all the machinery is furnished from a central power station, equipped with water-tube boilers, powerful air compressors, and a complete system of compressed-air mains, delivering power to all parts of the plant. The compressors have a capacity of 3,310 cubic feet of compressed air at a pressure of 80 to 90 pounds. The air is distributed among 16 drills, 26 hoisting engines, and 10 pumps, reheaters being placed at intervals in order to obtain the increase in economy, and avoid refrigeration. It is matter of interest to note that the hoisting engines are of the usual type intended for their own independent generation of steam. The compressed air is delivered into the boilers, these acting as reservoirs, and the operation is the same as if steam were used, except that the fire and water are absent. In addition to the actual quarrying and handling machinery a number of other mechanical appliances are employed. The sand is screened and handled by machinery and the mortar is machine mixed, all the power being obtained from the compressed-air plant, and wherever power can be employed it is used to supersede manual labor.

In addition to the actual work upon the dam itself, there was much preparatory work required, including the construction of a temporary dam and flumes for the diversion and control of the water during the construction. Details of this work are given, with interesting illustrations showing the plans and progress of the work up to the present. An idea of the magnitude of the undertaking will be gained from the figures of the contract. Thus there are 267,300 cubic yards of earth and 100,000 cubic yards of rock excavation to be done, and more than 275,000 cubic yards of masonry to be built.

The increased use of handling and conveying machinery in work of this kind is a most significant feature in the development of modern engineering methods. Formerly it was assumed that digging and hauling earth was the natural employment of laborers and horses, machinery being employed only where manual labor was impracticable or too expensive. Now it is found that manual labor is in nearly every case far more costly than the use of power appliances, and contractors equipped with modern machinery are nearly always able to make lower bids and greater profits than those who adhere to the old methods. The most effective kind of human labor is found in the application of intelligence to direct mechanical appliances, and nowhere is this more clearly shown than in such undertakings as that above described.

Modern Cooling Towers.

VERY early in the history of the steam engine it was found desirable to obtain the advantages of the condensation of steam and the benefit of a vacuum in locations where a sufficient supply of water for unlimited use was not available, and various methods were devised to enable the same body of water to be used repeatedly. As the amount of water required for the condensation of steam varies from twenty to thirty times the weight of the steam to be condensed, it is evident that this becomes an important question when, as is often the case, the cost of supplying this volume continuously is prohibitory.

The earlier methods consisted in the use of cooling ponds, so arranged as to expose a large surface and shallow depth to the action of the atmosphere, so that by radiation, and by the evaporation of a portion, the heat was abstracted. Such cooling ponds are sometimes provided with spraying devices, by which the hot water is showered into the air and allowed to fall into the pond in fine drops, and various devices for insuring a thorough exposure of the water to the cooling action of the air have been used. These methods, however, are only applicable in locations where ample space is available, and for use in large cities they are altogether impracticable.

The more modern method of cooling the water of condensation is by the use of the so-called cooling tower, in which the water of circulation is allowed to flow downward over some form of baffling surface against an upward current of air, the entire apparatus being contained in a vertical tower erected in convenient proximity to the engine room, in the yard, or even on the roof, in case of necessity.

The conditions of efficiency of such towers are investigated and discussed in an article by Mr. J. R. Bibbins, in a recent issue of *Engineering News*, from which we make an abstract.

The essential points of design may be divided into the three portions of cooling surface, draft, and water distribution. Since the abstraction of the heat from the water is the aim of the device, the cooling surface forms a most important feature in the design. This has passed through a course of evolution, including inclined board surfaces, brush-wood boughs, wire nettings, slats, short sections of pipe, etc., and at the present time a variety of these constructions are in use. In the experimental tower used by Mr. Bibbins in his investigations, the surface consisted of a number of mats made of slats of rough lath, these mats being so placed that the successive tiers intersected each other at right angles. Cooling surfaces of metal are to be recommended, since they permit a certain portion of the heat to escape by conductivity.

The draft through a cooling tower may be either natural or forced, the main object being to remove the saturated air and replace it with drier air as rapidly as the saturation takes place. Where natural draft can be used it is the cheaper, but in many instances where space is of importance it is preferable to use a fan, this enabling a smaller tower to do the work.

So far as the water distribution is concerned, the principal thing to avoid is the direct falling of the water for any distance, it being most desirable to have it thoroughly broken up and brought into intimate contact with the cooling air currents.

The tests made by Mr. Bibbins show some interesting facts, for details of which the original article must be consulted. The main conclusions were as follows:

Conduction plays a minor part in the process of temperature reduction; evaporation being the main agent. Maximum evaporation is obtained by effecting as thorough and uniform a water distribution over the entire surface as possible, it being most desirable to avoid falling water, while at the same time retarding the flow of the descending sheets. A liberal settling basin should be provided, and when natural draft is used there should be extensive air chambers at top and bottom, to provide good air distribution. Liberal stand-pipe capacity should be provided for reciprocating pumps.

Since the cooling is mainly due to the evaporation, it is evident that the loss of water from this cause must be taken into consideration. Experience shows that it may require the entire condensation from the engine to supply this loss, which is what might theoretically be expected.

While the cooling tower undoubtedly is a useful device in certain localities, it seems

as if the evaporative condenser, with proper design might in most instances be made to give as good results.

Instead of handling a volume of water about twenty-five times as great as the feed water, it should be possible to produce the evaporation of little more than the amount discharged by the engine, and thus absorb all the heat released by condensation. Evaporative condensers have given good results in a number of instances, and if this form was given the benefit of thorough investigation and experimental research it might be found the preferable type.

A Modernized Cruiser.

An interesting example of the changes and improvements which may be made in a modern cruiser after a comparatively short period of service is seen in the account of the repairs and alterations made to the U. S. S. Olympia, by Naval Constructor W. P. Roberts, in a recent issue of *Marine Engineering*.

The Olympia, it will be remembered, was built at San Francisco in 1895, and was found to be most effective in the performance of her duties as flag-ship at the battle of Manila in 1898. She has now been entirely re-equipped, with the exception of engines, boilers and armament, and it is interesting to observe how many improvements were found to have been developed in the comparatively short period of her career.

At the commencement of the repairs, which were made at the Boston Navy Yard, the vessel was stripped of all furniture, and of all sheathing against the bulkheads and inner surface of the hull, and the steel plates were thoroughly scaled and repainted within and without. Instead of using wooden sheathing, the officers' quarters were sheathed with asbestos, mounted on wire netting, this being fireproof and non-splintering, and affording an even temperature in various climates.

The ammunition hoists have been reconstructed and arranged to be operated by electric motors, and electric power has also been applied to the operation of the turrets, each turret being provided with a 20 kw. motor. These have been found much more effective than the former steam motors, and it is believed that this change greatly increases the effectiveness of the weapons in the turrets.

The value of rapid and effective coaling having been demonstrated in actual service, the Olympia has been fitted with machinery to increase her coaling facilities. Overhead trolleys have been fitted in the wing passages on each side the length of the upper bunkers, so that coal can be rapidly carried to and from any of the bunkers. Four special coal trolleys have been installed above the superstructure deck, arranged for coaling over all, this being a great improvement over the old method of coaling through hinged chutes in the sides of the vessel. The coal is now swung aboard in sacks and lowered through hatches directly upon trucks and delivered to the scuttles over the bunkers. The side chutes are retained, and can be used simultaneously with the trolleys, thus enabling coaling to be performed very rapidly.

The whole system of ventilation of the ship has been overhauled, there being nine electrically driven blowers employed, these avoiding the necessity of piercing bulkheads with large ventilating openings, required when fewer large fans are used.

The experience in active service as to the danger from fire has led to the provision of a very complete system of fire mains, a new feeder main being run under the protective deck, connected with powerful fire pumps in the engine rooms. The fire pipes are enameled inside, which is expected to add materially to their life.

As indicating the increase in the applications of electric power, it may be noted that the electrical output of the generators has been raised from 64 to 176 kilowatts. There are now four generators of 32 kw. and two of 24 kw., all being beneath the protective deck, the current being used for operating the turrets, fans, and electric hoists, as well as for the electric lighting of the ship and for the search lights.

As the vessel now exists she is an example of modern interior fitting and general equipment. The steam plant has been overhauled and put in order, and the distilling plant materially enlarged. It is interesting to note that the improvements are those which have been suggested by the experience in actual warfare.

THE ENGINEERING INDEX

THE ENGINEERING INDEX IS THE KEYSTONE OF APPLIED SCIENCE

The following pages form an index to the contents of nearly two hundred of the leading engineering journals of the world, in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index item gives the following essential information about every article.

(1) The full title, (2) The name of its author,
(3) A descriptive abstract, (4) Its length in words,
(5) When published, (6) Where published.

We supply the article itself, if desired.

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer and works manager may quickly turn to what concerns himself and his special branches of work. Thus this Index makes it possible within a few minutes' time each month to inform one's self of every important article published anywhere in the world upon the subjects claiming one's special interest.

The original of any article referred to in the Index, together with all illustrations, can be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the journals indexed are given.

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CIVIL ENGINEERING

BRIDGES.

Arch Truss.

The Cantilever Arch Truss. N. Clifford Ricker. Describes a novel method devised for finding stress diagrams, as there were difficulties in applying the usual methods of Graphic Statics for such a truss. 1600 w. Br Build—Feb., 1902. No. 40034 D.

Atbara.

The Atbara River Bridge. Brief illus-

We supply copies of these articles. See page 319.

trated account of the awarding of this work, method of erection, &c. 1200 w. Sci Am—March 15, 1902. No. 46809.

Basel.

The Competition for the Middle Rhine Bridge at Basel, Switzerland (Wettbewerb für den Neubau der Mittleren Rheinbrücke zu Basel). A review of the designs submitted in the competition for a bridge to replace one which has stood for centuries, with illustrations of the prize winners. Serial. 5 parts. 3 plates. 7000 w. Schweiz Bauzeitung—Jan. 18, 25, Feb. 1, 8, 15, 1902. No. 46992 each B.

Cambridge-Boston.

The Cambridge Bridge. Illustration, with description of one of the finest structures of its kind in the United States, now being built across the Charles River, Boston. 1200 w. R R Gaz—Feb. 28, 1902. No. 46574.

Cantilever.

The Highland Park Bridge, Pittsburg. Illustrated description of a cantilever highway bridge with unusual pedestal details, chord members and lateral systems. 3000 w. Eng Rec—March 22, 1902. No. 47035.

Concrete Arch.

A New Type of Concrete-Steel Arch Culvert or Bridge. Daniel B. Luten. Illustrated description of a method of reinforcing with a single series of steel rods and steel ties. 1400 w. Ry & Engng Rev —March 15, 1902. No. 47026.

Concrete-Steel Bridge Across Kenduskeag Stream, at Bangor, Maine. Illustrated description of a recently built bridge on the Ransome system. 700 w. Eng News—March 20, 1902. No. 47101.

Concrete-Steel Bridges for Interurban Railways. Daniel B. Luten. An illustrated article giving designs of this class of bridges and commending the material. 1400 w. St Ry Rev—March 15, 1902. No. 47016 C.

Rhodes Creek Concrete Arch, Illinois Central. Illustrates and describes an interesting elliptical concrete arch bridge, and the method of substituting the old steel structure without interrupting traffic. 3000 w. Ry Age, Special number—March 21, 1902. No. 47132 D.

Westvale Concrete Bridge. J. R. Worcester. Illustration with description of an elliptical arch bridge built wholly of concrete. It has a clear span of 66 ft. and a roadway of 35 ft. The construction is given in detail. 1600 w. Munic Engng—March, 1902. No. 46524 C.

Culverts.

The Design of Culverts and Other Masonry Arches (Note sur les Conditions d'Etablissement et de Stabilité des Ponts, Ponceaux et Aqueducs en Maconnerie, Murs de Soutenement). L. Lanave. An illustrated discussion of the design of masonry arches, particularly with reference to the amount of water flowing through them. 3000 w. Rev Technique—Feb. 10, 1902. Serial. 1st part. No. 47160 D.

Deformation.

Experiments on the Deformation of Bridges (Conférence sur l'Expérimentation des Ponts). M. Rabut. A well illustrated account of apparatus and experiments to determine the deflection and vibration of bridges under various loads. Diagrams. 12000 w. Ann d Ponts et Chaussées—3 Trimestre, 1901. No. 46917 E+F.

Erection.

Bridge Erection on the West Virginia Short Line R. R. An illustrated article describing the construction of a line 60 miles in length, which contains 54 steel bridges and three tunnels, one of the latter being 3300 ft. long. 2000 w. Ry & Engng Rev —March 15, 1902. No. 47025.

Ferry Bridge.

Aerial Transfer Ferry Bridge Over the Ship Canal at Duluth. Illustrates and describes a structure having novel and interesting features, designed to meet unusual conditions. 700 w. R R Gaz—March 14, 1902. No. 46829.

The New Ferry Bridge Across the Ship Canal at Duluth, Minn. W. B. Patton. Two-page plate of details, with illustrations and description. 3700 w. Eng News —March 20, 1902. No. 47104.

Inclined Bridges.

Influence of the Forces due to the Inclination and the Action of Brakes on the Principal Members of a Railway Bridge with a Heavy Grade (Influence des Efforts dus à l'Inclinaisan et à l'Action des Freins sur les Poutres Principales d' un Pont de Chemin de Fer à Forte Rampe). M. Rey. A mathematical discussion of the design of bridges inclined from the horizontal, particularly one on the Chamounix line. Illustrations. 2000 w. Rev Gen d Chemins de Fer—Feb., 1902. No. 47173 H.

Lift Bridges.

Lift Bridges over the Elbe-Trave Canal, Germany (Ponts Levants du Canal de l'Elbe à la Trave). An illustrated description of vertical lift bridges worked by hydraulic pressure and electric motors and by hand windlass. 1 plate. 1200 w. Génie Civil—Feb. 15, 1902. No. 46998 D.

Luxembourg Arch.

Some Reflections on the Luxemburg Bridge. Editorial discussion of the design and the use of stone as a structural material for bridges. Ill. 1700 w. Eng News—March 6, 1902. No. 46700.

The Erection of the Luxemburg Stone Arch. Illustrated detailed description of

We supply copies of these articles. See page 319.

the viaduct between the railway station and the city, which is the longest stone arch yet built, having a 277½-foot span. 1200 w. Eng Rec—March 1, 1902. No. 46611.

The Luxemburg 277-ft. Stone Arch Viaduct. A general description, with two-page plate, of the longest stone arch in the world, now being constructed over the deep valley of the Petrusse, to connect the city with its railway station. 2000 w. Eng News—Feb. 27, 1002. No. 46569.

Pittsburg, Pa.

The Monongahela Bridge for the Wabash Railroad at Pittsburg. States the requirements to be met and gives an illustrated description of a remarkable bridge of the cantilever type, intended for the heaviest double-track modern service. 700 w. R R Gaz—March 14, 1002. No. 46832.

Plate Girders.

Formulæ for the Weights and Economic Depths of Plate Girders. Alfred Fyson. Gives formulæ designed to include every condition of span, depth, load and unit strain which can obtain in practice, and explains the method adopted in arriving at the separate expressions which give the weights. 2800 w. Engng—March 14, 1902. Serial. 1st part. No. 47080 A.

Plate-Girder Webs. T. Graham Gribble. Also editorial. Calls attention to the need for a revision of current theories as to the resistance of plate-girder webs. Examines the properties and the way in which the theory of construction deals with them. Ill. 6500 w. Engng—Feb. 21, 1902. No. 46596 A.

Redheugh Bridge.

The New Redheugh Bridge at Newcastle-on-Tyne. Illustrations of a reconstruction with several new features, with brief description. 1100 w. Sci Am—Feb. 22, 1902. No. 46501.

Renewal.

Renewal of the Florence Bridge, Louisville and Nashville and Southern Railways. Describes a novel method of renewing a bridge of 12 spans of about 120 ft. each. Ill. 400 w. Ry & Engng Rev—March 15, 1902. No. 47028.

Roath Dock Bridge.

Roath Bridge, Great Western Railway. Illustrated detailed description of this structure, which is on the very severe angle of skew of 22 deg. Its skew and square spans measure respectively 228 ft. and 76 ft. 3 in. 3000 w. Engr, Lond—Feb. 28, 1902. No. 46732 A.

Stiffening.

The Stiffening Trusses of Long-Span Railway Suspension Bridges. Editorial discussion of the relation between stiffness and cost in such bridges. 1400 w. Eng Rec—March 22 1902. No. 47033.

Suspension Bridges.

The Stiffening System of Long-Span Suspension Bridges for Railway Trains. Joseph Mayer. A comparison of the merits of various types, based on designs furnished for a bridge across the Hudson at New York. The bridge under discussion has twelve tracks. 17900 w. Pro Am Soc of Civ Engrs—Feb., 1902. No. 46533 E.

Swing Bridge.

A Counterbalance Swing Bridge on the Chicago, Milwaukee & St. Paul. Illustrated description of a new bridge over the Ogden canal, at Cherry street, in Chicago, of the pin-connected truss type. Electricity will be used for operating the bridge. 500 w. Ry Age—March 7, 1902. No. 46759.

A Non-Continuous Swing Bridge. Explains the ordinary construction of swing bridges, and improvements made at different times to overcome difficulties, simplify the operating machinery, and improve them, giving a detailed description of a design recently patented by Charles Worthington, so improved as seemingly to overcome all objections. Ill. 2500 w. Eng News—Feb. 27. 1902. No. 46563.

Viaur.

The Construction of the Viaur Viaduct (Notes sur la Construction du Viaduc der Viaur). M. Théry. A long article giving the calculations for this great steel arch in southern France, descriptions of which by the same author have already been indexed. Tables. Diagrams. 1 plate. 18000 w. Ann d Ponts et Chaussées. 3 Trimestre, 1901. No. 46919 E+F.

Y-Bridge.

The Zanesville Concrete-Steel Y-Bridge. Illustrated detailed description of this bridge and its construction. 1800 w. Eng Rec—March 1, 1902. No. 46609.

CANALS, RIVERS AND HARBORS.

Dams.

A New Automatic Movable Dam. Illustrated description of automatic wickets on top of a masonry dam which close during low water and open during floods 1500 w. Eng Rec—March 8, 1902. No. 46738.

A Severe Test of a Dam. Illustration with brief description of the flood at the Elmhurst dam of the Scranton Gas and Water Co. 600 w. Eng News—March 20, 1902. No. 47107.

Some Thoughts Suggested by the Recent Failures of Dams in the South. Robert L. Johnson. In the writer's opinion the failures were due to too light a section. 1700 w. Eng News—March 20, 1902. No. 47106.

The Melones M. Co. Dam, Stanislaus River, Cal. Plans of the site and plan and elevation of the dam, with views of the

construction at several stages, and of the flume leading from the dam to the mill, with descriptive notes. 900 w. Min & Sci Pr—March 8, 1902. No. 46806.

Danube.

The Regulation of the Austrian Danube (Ausbildung der Fahrrinne in der Oesterreichischen Donau). Arthur Herbst. An illustrated account of the work of deepening the channels and improving the navigation on the Danube. 3 plates. 1000 w. Oesterr Wochenschr f d Oeffent Baudienst—Feb. 8, 1902. No. 46932 B.

Docks.

Avonmouth Docks. Plan of this new dock which is to be constructed. It provides for the reclamation of a large tract of tidal flats. 700 w. Engr, Lond—March 7, 1902. No. 46863 A.

Extensive Ore Dock Improvements. On the wonderful developments in hoisting and conveying machinery, and the changes still in progress; the automatic unloaders. Also considers the more substantial form of dock construction. Ill. 4000 w. Marine Rev—March 6, 1902. No. 46757.

Canal Haulage.

Mechanical Traction on the Nivernais Canal. Brief description, with illustrations of mechanical haulage by means of an universal chain. 400 w. Engng—March 7, 1902. No. 46857 A.

China.

Transportation in China (Verkehrwege Chinas). Dr. Franz Ritter v. Le Monnier. A paper giving a comprehensive review of the navigable rivers, canals, and railways, both existing and projected in China. Serial. 3 parts. 1300 w. Zeitschr d Oesterr Ing u Arch Ver—Feb. 7, 21 and 28, 1902. No. 46938 each B.

Hydro-Electric Plants.

See Electrical Engineering, Generating Stations.

Inclined Planes.

Canal Lifts on the Austrian Waterways (Die Anlage von Schiffshebewerken im Zuge der Oesterreichischen Wasserstrassen). Emil Krumholz. Illustrated plans for transporting vessels from one level to another and over an intervening ridge. 3 plates. 9000 w. Oesterr Wochenschr f d Oeffent Baudienst—Feb. 22, 1902. No. 46935 B.

The Construction of Inclined Planes for Transporting Vessels (Zur Construction von Geneigten Ebenen für Schiffstransport). Franz Prasil. An illustrated description of an inclined plane system for shifting canal boats from one level to another. 1 plate. 1800 w. Oesterr Wochenschr f d Oeffent Baudienst—March 1, 1902. No. 46936 B.

Isthmian Canal.

The Reports of the Isthmian Canal Commission. John Geo. Leigh. A critical analysis of the respective routes, based upon the reports of the Isthmian Canal Commission, and showing the superiority of the Panama route. 4000 w. Engineering Magazine—April, 1902. No. 47180 B.

Jetty Repair.

The Launching of Concrete and Masonry Blocks in Repairing Jetties (Note sur le Lancement des Blocs Artificials Employés pour l'Entretien des Jetés). M. Chevalier. An illustrated description of a method of launching large and heavy blocks into place. 700 w. Rev Technique—March 10, 1902. No. 47165 D.

Konigsberg.

The Königsberg Canal (Der Königsberger Seekanal). F. Jerosch. An illustrated description of a ship channel made through the shallow waters of the "Frische Haff" from Königsberg to the Baltic Sea. 2000 w. Deutsche Bauzeitung—Feb. 1, 1902. No. 46900 B.

Lighthouses.

The Visibility of Twin Lighthouses (Vision des Feux Associés). M. de Joby. A comprehensive discussion of the visibility of lighthouses, particularly those grouped in pairs. 8000 w. Ann d Ponts et Chaussées—3 Trimestre, 1901. No. 46-916 E+F.

River Flow.

The Laws of River Flow. C. H. Tutton, Gives a theory advanced by D. T. Smith, of the Louisville (Ky.) University, with views of other writers. 2600 w. Jour Assn of Engng Socs—Jan., 1902. No. 46707 C.

The Natural Normal Sections of Streams (Die Natürlichen Normalprofile der Fliessenden Gewässer). Richard Siedek. A paper discussing the ideal condition of water flow in rivers, and the regulation of streams in harmony with natural laws. Diagrams. 1 plate. 6500 w. Zeitschr d Oesterr Ing u Arch Ver—Feb. 21, 1902. No. 46942 B.

River Gauging.

River Gauging With Rod Floats. Geo. W. Brown. Gives in detail a method of stream gauging by use of rod floats, with an outline of the reductions. 2500 w. Wis Engr—Feb., 1902. No. 46528 D.

River Improvements.

Reasons for the Failure of River Regulation Works. Discussion by Major D. C. Kingman, U. S. A., of the reasons why river improvements by regulation have often been unsatisfactory. 1700 w. Eng Rec—March 22, 1902. No. 47038.

Seaport.

Dalmy, the Russian Commercial Sea-

port in North China. A full account of this commercial seaport, established by the Russian government, its location, harbor, piers, etc., with maps and illustrations. 3500 w. U S Cons Repts, No. 1291—March 17, 1902. No. 46871 D.

Weir.

The Floating Shutter Weir (Das Schwimmklappenwehr, ein Neues Beweglicher Stauwerk). Emil Grohmann. An illustrated paper giving a description of a weir in which the shutters are moved by pumping water in and out of the lower part which is hollow. 1 plate. 9000 w. Zeitschr d Oesterr Ing u Arch Ver—Feb. 7, 1902. No. 46939 B.

Whampou River.

Improvement of the Whampou River by the Removal of the Wu Sung Bar (Amelioration de la Navigabilité de la Rivière Whampou par la Supression de la Barre de Woosung. J. J. Chollot. Project for the improvement of the river connecting Shanghai with the Yangtse-Kiang, with extract from engineers' report and Chinese treaty. Map. 7000 w. Mem d l Soc d Ing Civils de France—Jan., 1902. No. 47-169 G.

Zuider Zee.

The Draining of the Zuider Zee. Prof. J. H. Gore. Describes the proposed work and the methods of carrying it out, giving related information. 2500 w. Pop Sci M—April, 1902. No. 47087 C.

CONSTRUCTION.

Building Construction.

Construction of the Remsen Building, New York. Illustrated description of the method of building a 16-story steel-cage office building and of special derricks used in the work. 2800 w. Eng Rec—March 22, 1902. No. 47041.

Structural Details of the Waterside Power Station, New York. Illustrated description of the steel work, including columns and coal pockets, roof-trusses, and smoke-stack platforms in a 197x272 ft. power station rising 155 ft. above the ground. 6700 w. Eng Rec—March 15, 1902. No. 46882.

The Chamber of Commerce Building, New York. Illustrated detailed description of the building and its arrangement. 1800 w. Eng Rec—March 1, 1902. No. 46612.

The Hanover National Bank Building, New York. Illustrated description of the steel-work in a 111x98 ft. office building rising 330 ft. above the sidewalk. 2000 w. Eng Rec—March 8, 1902. No. 46741.

Concrete Factory.

A Jersey City Concrete Factory Building. Illustrated description of large concrete steel cantilever floor supports and of the method of handling the concrete. 1500 w. Eng Rec—March 22, 1902. No. 47036.

Fire-Proofing.

Notes on Fire-Proof Construction Under the System Monier. E. Lee Heidenreich. An illustrated article describing important uses made of this construction in the United States. 1200 w. Ry & Engng Rev—March 15, 1902. No. 47022.

Rational Methods of Fireproofing. William Copeland Furber. Some suggestions, especially to manufacturers of fire clay materials. Ill. 1500 w. Br Build—Feb., 1902. No. 46635 D.

Foundations.

The Construction of Foundations for Buildings. Gerald E. Flanagan. Some points in the construction of foundations for heavy loads. 1200 w. Am Mach—March 27, 1902. No. 47144.

Grain Elevator.

Fireproof Grain Elevator Construction. James MacDonald. Describes the ordinary construction, where wood was the material most generally used, and gives an illustrated description of a system consisting of a combination of tile and reinforced steel members. Discussion. 8500 w. Jour W Soc of Engrs—Feb., 1902. No. 46-704 D.

Piles.

The Supporting Power of Piles. Discussion by E. Sherman Gould of paper by Ernest P. Goodrich. 900 w. Pro Am Soc of Civ Engrs—Feb., 1902. No. 46535 E.

The Supporting Power of Piles. George F. Cotterill. Describes the failure of a timber wharf in Seattle and many experiments on models to determine the strength of the piling in the structures. 3000 w. Eng Rec—March 8, 1902. No. 46744.

Roads.

Cost of Building Macadam Roads at Port Huron, Mich. Frank F. Rogers. Abstract of a paper read at Grand Rapids, before Mich. Engng. Soc. A brief illustrated description of two roads, with summary of cost. 2000 w. Eng News—March 6, 1902. No. 46699.

State Road Construction in New Jersey. Explanation, from official reports, of the remarkable success of State aid for New Jersey highways. 1800 w. Eng Rec—March 22, 1902. No. 47039.

Tunnels.

Progress of the Simplon Tunnel (I Lavori del Traforo del Sempione). A. Ferrucci. An analysis of the work done at the various headings during the last quarter of 1901. 2000 w. Gior d Lav Pub e d Str Ferr—Feb. 26, 1902. No. 47190 D.

The Construction of the Aspen, Wyoming Tunnel on the Union Pacific Railroad. W. P. Hardesty. An explanation of re-

cent improvements on this road for shortening the line and improving the grade, with illustrated description of the interesting features in connection with the tunnel named. 3700 w. Eng News—March 6, 1902. No. 46697.

The Ventilation of the Simplon Tunnel. Illustrated description of the ventilating plant employed in tunneling about 12¼ miles under mountains so high that the natural rock temperature is over 100 degrees F. for half the distance. Gives the temperature and humidity readings in different parts of the tunnel. 2600 w. Eng Rec—March 8, 1902. No. 46740.

MATERIALS.

Austrian Report.

Report of the Building Materials Committee (Bericht des Baumaterialien-Ausschusses). Karl Stöckl. A report of a committee of the Austrian Society of Engineers and Architects, with tables for all kinds of building materials and for floors, roofs, etc., with discussion. 4000 w. Zeitschr d Oesterr Ing u Arch Ver—Special Supplement Feb. 21, March 7, 1902. No. 46943 each B.

Bitumen.

Bitumen in Cuba. T. Wayland Vaughan. Account of occurrences of bitumen in Cuba obtained partly during geological research, and partly from existing literature. Ill. 5800 w. Eng & Min Jour—March 8, 1902. No. 46787.

Cement.

Data and Notes Derived from Tests on Cement and also on Concrete Taken from Regular Batches Used in Actual Works. James S. Costigan. 5600 w. Can Soc of Civ Engrs, Adv. Proof—Feb. 27, 1902. No. 46519 D.

Cement Works.

The Rudelsburg Portland Cement Works. Illustrates and describes an interesting plant erected under unusual difficulties, because of the severe requirements never before imposed on a Portland Cement company. 2200 w. Eng Rec—March 1, 1902. No. 46610.

Fire Protection.

Portland Cement Concrete as a Protection from Fire. Charles L. Norton. An illustrated account of tests made to find the temperature of steel framework during a very severe fire test. 1000 w. Ins Engng—Feb., 1902. No. 46518 C.

Paving Brick.

Specifications for Paving Brick for Use at Wheeling, W. Va. Reprint of specifications relating to quality, dimensions, test, inspection, etc. 800 w. Eng News—Feb. 27, 1902. No. 46566.

Reinforced Concrete.

Tests of Reinforced Concrete Beams (Epreuves sur des Poutres en Ciment Armé). An illustrated account of tests of Monier beams made by the Wittenburg Company of Amsterdam. 800 w. Génie Civil—March 8, 1902. No. 47156 D.

Theory of the Strength of Beams of Reinforced Concrete. W. Kendrick Hatt. Abstract of a paper presented to the Indiana Engng. Soc. A computation of the strength of such beams. Mathematical. 3000 w. Eng News—Feb. 27, 1902. No. 46564.

See Civil Engineering, Bridges.

Timber Preservation.

The Hasselmann Process for Timber Preservation (Die Timber Preservation des Imprägnierverfahrens Hasselmann auf Schwellen und Nutzholz). From *Tiefbau*. A description of a process in which the preserving substances, generally metallic salts, are chemically united with the wood, which is also rendered fireproof. 1500 w. Gluckauf—Feb. 1, 1902. No. 46978 B.

MEASUREMENT.

Alaska Frontier.

The Alasko-Canadian Frontier. Thomas Willing Balch. A review of the entire negotiations relating to the purchase of Alaska with a view of determining the boundary. Maps. 8500 w. Jour Fr Inst—March, 1902. No. 46794 D.

Stadia Work.

A Few Notes on the Use of the Plane-table for Rapid Stadia Work. John W. Hays. Notes from experience, describing the use of this instrument and the methods. 2200 w. Eng News—March 13, 1902. No. 46801.

MUNICIPAL.

Fire Apparatus.

A Pneumatic Fire Escape and Tower. William S. Crandall. Illustrated description of the pneumatic telescopic aerial truck of the city of Pittsburg. 800 w. Sci Am—March 8, 1902. No. 46691.

Pavements.

Tar Macadam in Pawtucket. Resume of ten years' experience with tar and bituminous macadam on streets having moderately heavy traffic. 900 w. Eng Rec—March 8, 1902. No. 46737.

Refuse Disposal.

The Present State of Refuse Disposal in Different Countries (Etat Actuel de la Question des Ordures Méenageres dans les Divers Pays). Ach. Livache. An illustrated, comprehensive review of the subject, founded largely on W. F. Goodrich's book. 15000 w. Bull Soc d'Encouragement—Feb., 1902. No. 47158 G.

Sewage Purification.

Old and New Methods of Sewage Puri-

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nication at Pawtucket, R. I. Summary from a paper by George A. Carpenter, of work with the sentic tank and with bacteria beds, and the intermittent sand filters. 2500 w. Eng News—Feb. 27, 1902. No. 46567.

Sewers.

Early History of the Separate Sewerage System. States facts concerning early failures of separate sewers of too small diameter. 1000 w. Eng Rec—March 8, 1902. No. 46712.

The Use of Concrete in Sewer Construction. Harry V. Gifford. Read before the Mich Engng. Soc. Describes a sewer built at Coldwater, Mich., giving a full account of the work with illustrations. 3000 w. Munic Engng—March, 1902. No. 46526 C.

Street Sprinkling.

The Sprinkling of Streets in Paris (L'Arrosement de la Voie Publique à Paris). E. Bret. A well illustrated account of street sprinkling and flushing, and the apparatus used. 4000 w. Génie Civil—Feb. 22, 1902. No. 47,151 D.

WATER SUPPLY.

Epidemics.

The Recent Epidemic of Typhoid Fever at Baraboo, Wis., and its Probable Relation to the Water Supply. W. G. Kirchoffer. Describes the location of the city, the source of water supply, plant, etc., and concludes that it is not safe to run a pure water main through polluted water with no other protection than a lead joint. Ill. 1500 w. Eng News—Feb. 27, 1902. No. 46562.

Ground Water.

The Measurement of Ground Water (Versuchsbrunnenanlagen). Hr. Prinz. A paper on the importance of ground water supplies, and methods of determining the amount available, by means of experimental wells, etc. 4500 w. Gesundheits, Ing—Jan. 31, 1902. No. 47196 B.

Meters.

Notes on Water Meters (Note sur les Compteurs d'Eau). M. Couronne. An account of Paris regulations and laboratory for testing meters, and an illustrated review of many types. Serial. 1st part. 4000 w. Rev de Mecanique—Jan., 1902. No. 47167 E+F.

Purification.

Water Purification. P. A. Maignen. A review of the history of filtration, appliances used, results, etc. Ill. 8000 w. Jour W Soc of Engrs—Feb., 1902. No. 46705 D.

Reservoirs.

Construction of the Forbes Hill Reservoir and Stand-Pipe at Quincy, Mass. C. M. Saville. Illustrated description of work carried out to furnish storage and protection to the southern part of the Metropolitan water district, and to provide for sudden and unusual drafts. 6000 w. Eng News—March 13, 1902. No. 46805.

Forbes Hill Reservoir and Water Tower, Quincy, Mass. Alfred D. Flinn. Illustrated description of a steel standpipe enclosed in a masonry tower, and of an open basin with a very thick concrete lining of unusual construction. 2200 w. Eng Rec—March 15, 1902. No. 46880.

St. Louis.

Report of the St. Louis Water Supply by an Expert Commission. Abstracted by Robert E. McMath. 9000 w. Eng News—March 6, 1902. No. 46701.

Water Mains.

Electrolysis Investigations at Erie, Pa. Illustrated description of some unusual results due to electricity leaving the street railway tracks. 1200 w. Eng Rec—March 8, 1902. No. 46739.

Water Sheds.

The Drainage of Swamps for Watershed Improvement. Edward S. Larned. An illustrated article explaining methods used in draining the Sudbury watershed in Massachusetts, giving costs. Also discussion. 5000 w. Jour N E Water Wks Assn—March, 1902. No. 46651 F.

Water Tank.

Stresses in a Conical Bottomed Water Tank. Illustrated analysis of the stresses in a tank like that which collapsed in 1901 at Fairhaven, Mass. 700 w. Eng Rec—March 8, 1902. No. 46745.

Water Works.

The Water-Works System of Middletown, N. Y. Brief history of the works with illustrated description of improvements and additions now under construction. 1000 w. Munic Engng—March, 1902. No. 46525 C.

ELECTRICAL ENGINEERING

COMMUNICATION.

Cable Laying.

Submarine Cable Laying During a Canadian Winter. G. U. G. Holman. Illustrates and describes the laying of a cable between Quebec and Levis, Canada. 2200 w. Elec Wld & Engr—March 22, 1902. No. 47098.

Cable.

The Imperial Cable. An interesting ac-

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count of the All-British cable now in course of construction, which will connect England with Canada, Fiji and other South Sea Islands, Australia and New Zealand. 4000 w. Engr, Lond—Feb. 21, 1902. No. 46599 A.

Duplex.

Improvements in Hughes Duplex Telegraphy (Verbesserungen in der Hughes Duplex-Telegraphie). J. Jokisch. An illustrated description of a refined differential duplex arrangement. 1500 w. Oesterr Wochenschr f d Oeffent Baudienst—Feb. 15, 1902. No. 46934 B.

Exchanges.

The City Exchange of the Post-Office Telephone Department. Illustrated technical description of the telephone system being erected in London, and of the equipment of the new city exchange. 2500 w. Elect'n, Lond—March 7, 1902. Serial. 1st part. No. 46850 A.

The Equipment of a Modern Telephone Exchange. F. A. S. Wormull. Read before the Newcastle Sec. of the Inst. of Elec. Engrs. Illustrates and describes three systems as representative of the most recently built exchanges in England. 4500 w. Elec Engr Lond—March 7, 1902. No. 46853 A.

The Janus Branch Exchange System for Business Telephony (Janusnebenstellen-System für Geschäftstelephonie). Hans Zopke. A well illustrated description of a switchboard system for changing connections fro an interior network to the public lines and vice versa. 3000 w. Elektrotech Zeitschr—Feb. 20, 1902. No. 46950 B.

Faults.

The Final Localization of "Earths" on Low-Tension Networks. A. P. McDouall. Concernings the means of locating a fault when the solid system of laying mains is used, describing the loop test. 1000 w. Elec Rev, Lond—March 14, 1902. No. 47071 A.

Space Telegraphy.

Marconi's Wireless Telegraph Company. Gives Mr. Marconi's address to the shareholders at a recent meeting in England. 4800 w. Elec Rev, Lond—Feb. 28, 1902. No. 46718 A.

Mr. Marconi's Latest Achievement in Ocean Wireless Telegraphy. Wilfrid Blaydes. A report of the recent trip of the "Philadelphia" with a reproduction of the signal received 2099 miles. 1200 w. Elec Wld & Engr—March 8, 1902. No. 46786.

New Slaby-Arco Wireless Telegraph Installation. From *Elektrotechnische Zeitschrift*. Describes some installations of this system. 900 w. Elect'n, Lond—Feb. 21, 1902. No. 46584 A.

On the Elevation of the Electrically-Conducting Strata of the Earth's Atmosphere. A. E. Kennelly. Interesting reasoning explanatory to the propagation of the waves in wireless telegraphy. 500 w. Elec Wld & Engr—March 15, 1902. No. 47008.

Slaby-Arco Wireless Telegraph Apparatus. A. Frederick Collins. Illustrated description of this system and the apparatus used. 1800 w. Elec Wld & Engr—March 1, 1902. No. 46619.

Space Telegraphy (Rundschau). An editorial on Marconi's recent work, on the practicability of transoceanic operation, and on the necessity to the improvement of details in short and medium distance work. 800 w. Elektrotech Zeitschr—March 13, 1902. No. 46958 B.

The Guarini Repeating Wireless Telegraph System. A. Frederick Collins. Illustrated description of the system of M. Emile Guarini, and his repeating device. 2000 w. Sci Am—March 8, 1902. No. 46693.

The Paternity of Wireless Telegraphy. Discusses the claims of Dr. E. Branly, of France, and shows that many have contributed to the discovery and perfection of wireless telegraphy. Ill. 2500 w. Elec Engr, Lond—Feb. 21, 1902. No. 46583 A.

The Scientific Foundations of Spark Telegraphy (Die Wissenschaftlichen Grundlagen der Funkentelegraphie). Prof. A. Slaby. An illustrated review of the theory and fundamental experiments of wireless telegraphy. 3000 w. Elektrotech Zeitschr—Feb. 27, 1902. No. 46951 B.

Wireless Telegraphy and Submarine Cables. Emile Guarini. Discusses various sides of the question relating to the practical use of wireless telegraphy across the oceans, making comparisons with the cable. 3800 w. Elec Rev, Lond—Feb. 28, 1902. No. 46719 A.

Telegraphy.

The Burry Ticker and Page Printing Telegraph. Frank C. Perkins. Illustrated description. 1300 w. Elec, N Y—March 19, 1902. No. 46878.

Telephony.

Features of Modern Telephone Work. Address of J. J. Carty to the N. Y. Elec. Soc. at the new Cortlandt St. Exchange of the N. Y. Telephone Co. 2800 w. Elec Wld & Engr—Feb. 22, 1902. No. 46515.

The Faller System of Automatic Telephony. Illustrated description. 1700 w. Elec Rev, N Y—March 22, 1902. No. 47097.

DISTRIBUTION.

Accumulator Switch.

An Automatic Storage Battery Switch (Ueber einen Neuen Selbstthätigen Zellenschalter). Paul Thieme. An illus-

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trated description of a switching apparatus for automatically cutting in and out cells of arc accumulator battery, and a general review of such switches. 2000 w. Elektrotech Zeitschr—Feb. 27, 1902. No. 46952 B.

Booster.

The Diminishing of Earth Currents on Alternating-Current Railways with Track Return Circuit (Verminderung der Erdströme bei mit Wechselstrom betriebenen Ueberlandbahnen mit Schienenrückleitung). Emil Ziehl. An illustrated account of experiments confirming Gisbert Kapp's method of using boosters at points along the railway. 2000 w. Elektrotech Zeitschr—Feb. 20, 1902. No. 46948 B.

Conduits.

A New Electric Conduit System (Ueber ein Neues Installationssystem). A. Peschel. Paper before the Elektrotechnischer Verein, giving illustrated description of a conduit system consisting of split steel tubes which can be cut in any suitable length and whose ends fit tightly into connecting pieces. 4000 w. Elektrotech Zetischr—March 6, 1902. No. 46957 B.

Economical Section.

The Economical Section of Conductors (Die Berechnung der Leitungen auf Wirthshaftlichkeit der Anlage). Prof. J. Teichmüller. A discussion of various formulæ for the most economical size of conductor for a given power transmission plant, with an attempt to harmonize them. Diagrams. 5500 w. Elektrotech Zeitschr—March 6, 1902. No. 46955 B.

Karlsruhe.

See Electrical Engineering, Generating Stations.

ELECTRO-CHEMISTRY.

Alkali.

Electrolytic Production of Alkali. An illustrated description of the Middlewich Works and the processes, with an account of the investigations of Dr. Sproesser, concerning the suitability of various carbons as anodes for the electrolysis of sodium chloride. 2800 w. Engng—March 14, 1902. No. 47086 A.

Alkali Works.

The Electrolytic Alkali Company's Works. Illustrated description of the works at Middlewich, where the Hargreaves-Bird process is used. 2700 w. Elec Engr, Lond—March 14, 1902. No. 47070 A.

ELECTRO-PHYSICS.

Earth Currents.

Experiment Investigation of Electric Earth Currents (Untersuchungsergebnisse über den Natürlichen Elektrischen Erdstrom). E. Jahr. A record of experiments in the vicinity of Berlin, showing the influence of the relative positions of the earth plates, etc. 2400 w. Elektrotech Zeitschr—March 6, 1902. No. 46956 B.

Electric Waves.

The General Problem of Wave Propagation Over Non-Uniform Conductors. M. I. Pupin. Showing that the mathematical solution of the problem of wave propagation over non-uniform conductors of the series type is the most general solution because every other case can be deduced from it. 2400 w. Elec Wld & Engr—March 1, 1902. No. 46621.

Electrodynamics.

Electrodynamics of Moving Bodies (Electrodynamique des Corps en Mouvement). E. Carvallo. The application of electrodynamic equations, founded on a generalization of Kirchoff's two laws, to moving bodies. 700 w. Comptes Rendus—Jan. 20, 1902. No. 47179 D.

Electrons.

Radio-Activity and the Electron Theory. Sir William Crookes. Read before the Royal Soc. An illustrated account of experimental investigations. 2700 w. Nature—Feb. 27, 1902. No. 46710 A.

Interrupter.

A Carbon Electrolytic Interrupter. A. H. Taylor. Describes a cheap, simple, self-adjusting instrument suited for continuous service. Ill. 1500 w. Elec, N Y—March 5, 1902. No. 46643.

A Modified Wehnelt Interrupter. Prof. A. L. Foley and R. E. Nyswander. Illustrates and describes an interrupter used for more than two years in the Indiana University Physics Laboratory with better results and less trouble than any others of the electrolytic type. 1000 w. Elec Wld & Engr—March 1, 1902. No. 46618.

Magnetic Declination.

Results of Magnetic Observations at Bochum, Westphalia, in 1901 (Ergebuisse der Magnetischen Beobachtungen in Bochum im Jahre 1901). Hr. Lenz. Curves and tables of the magnetic declination for every hour of the year. Glückauf—Special Supplement. Feb. 1, 1902. No. 46976 B.

Magnetic Expansion.

The Magnetic Expansion of Iron and Steel. Philip E. Shaw, and S. E. Laws. Thorough investigation of Swedish iron, mild steel and hard steel. Ill. 3000 w. Elect'n, Lond—Feb. 21, 1902. Serial. 1st part. No. 46587 A.

Magnetic Properties.

The Conductivity and Magnetic Properties of Alloys of Iron. Abstract of a paper by Prof. W. F. Barrett and W. Brown,

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read at meeting of the Inst. of Elec. Engrs, England. Discusses electric conductivity, magnetic properties, non-magnetic alloys of iron, alloys of iron more magnetic than the purest commercial iron, etc. 3200 w. Elect'n, Lond—Feb. 21, 1902. No. 46-585 A.

Magnetism.

The Electrical and Magnetic Properties of Iron Alloys. Editorial on the researches of Prof. Barrett, with Messrs. Brown and Hadfield. 1200 w. Engng—March 14, 1902. No. 47085 A.

Radiography.

Some Properties of the Rays from Radio-Active Bodies (Sur quelques Propriétés du Rayonnement des Corps Radioactifs). Henri Becquerel. Notes on experiments with uranium, radium, etc. 900 w. Comptes Rendus—Jan. 27, 1902. No. 47191 D.

The Experimental Classification of Different Kinds of X Rays by Means of the Radiochromometer (Definition Expèrimentale des Diverses Sortes de Rayons X, par le Radiochromomètre). L. Benoist. A description of an instrument which classifies the degree of penetration of different kinds of X rays, and applications. 500 w. Comptes Rendus—Jan. 27, 1902. No. 47-192 D.

Thermo-Electricity.

The Thermo-Electric Properties of Steel and Nickel-Steel (Sur la Thermo-Electricité des Aciers et des Ferro-Nickels). G. Belloc. A record of experiments with alloys with various percentages of nickel to determine the temperature of the neutral point and the electromotive force. 400 w. Comptes Rendus—Jan. 13, 1902. No. 47177 D.

Vacuum Tubes.

Distribution of Current at the Surface of Cathodes in Vacuum Tubes. A. Wehnelt. Translated from *Ann. der Physik.* Considers the distribution of current in cathodes not completely covered with glow light, at the surface of completely covered plane cathodes, at the surface of curved cathodes, and the influence of the material and the surface condition upon the distribution between two parallel cathodes. Ill. 4500 w. Elect'n, Lond—March 14, 1902. No. 47074 A.

GENERATING STATIONS.

Armature Winding.

The Theory of the Equipotential Connections of the Armatures of Direct Current Machines (Theorie der Aequipotential-Verbindungen der Anker von Gleichstrommaschinen). Prof. E. Arnold. A mathematical discussion of the connection of equipotential points of the armature winding. Diagrams. Serial. Part I. 3000 w. Elektrotech Zeitschr—March 13, 1902. No. 46960 B.

Bankside.

The City of London Electric Lighting Company's Works. Illustrated article describing the extension and changes from alternating to continuous current at the Bankside Works. 3000 w. Elec Engr, Lond—Feb. 28, 1902. No. 46716 A.

The Direct-Current Plant at Bankside. Illustrated description of the plant and engine-room with which the continuous-current supply has been given. 2300 w. Elec Times—Feb. 27, 1902. No. 46711 A.

Dynamos.

Designing of Continuous Current Dynamos. Aubrey Clayton. Discusses the subject of commutation. 1800 w. Elec Rev, Lond—Feb. 21, 1902. No. 46582 A.

Large Generators for Bolton Corporation. Illustrated account of the tests of two 1100 kilowatt machines at the works of the English Electric Manufacturing Company. 2200 w. Tram & Ry Wld—Feb. 13, 1902. No. 46589 B.

Hydro-Electric Plants.

Development of a Great Water Power System at Hartford, Conn. Alton D. Adams. A detailed report of the operation of the Hartford Electric Light Company during the last ten years. The plant is a combined steam and water plant. Ill. 3300 w. Elec Wld & Engr—March 8, 1902. No. 46784.

Hydro-Electric Plants in the Alps (Les Installations Hydro-Electriques dans la Region des Alpes). M. de la Brosse. A well illustrated comprehensive report on a number of plants in the French Alps and about Geneva. 17000 w. Ann d Ponts et Chaussées—3 Trimestre, 1901. No. 46915 E+F.

The Dam and Power Station of the Hudson River Water Power Co. Illustrated description of a large masonry dam and power house at Spier Falls, for developing 20,000 H-P. 1400 w. Eng Rec—March 8, 1902. No. 46736.

Karlsruhe.

New Electric Stations (Neuere Elektrizitätswerke). Felix Winawer. An illustrated description of the electric station at Karlsruhe, Baden, and the distribution plant. 2000 w. Elektrizität—Jan. 18, 1902. No. 47198 C.

Los Angeles.

The System of the Los Angeles Electric Company. Illustrates and describes the new power house of the Los Angeles Elec. Co. and its equipment. 1500 w. Jour of Elec—Feb., 1902. No. 46879.

Power Plant.

A Modern District Central Station. Illustrated detailed description of the plant of the Westchester Lighting Company, at

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New Rochelle, N. Y. 2200 w. Am Elect'n —March, 1902. No. 46677.

Design for a Power Station in Providence. Illustrated detailed description of a plant in process of construction. 1800 w. St. Ry Jour—March 1, 1902. No. 46772 D.

New Power Plant of the National Cash Register Co., Dayton, Ohio. Fred W. Ballard. Illustrated detailed description of a new plant under construction. 5000 w. Engr, U S A—March 1, 1902. No. 46670.

Notes on the Care of the Power House. Arthur B. Weeks. An illustrated article on repairs to station circuit-breakers. 1600 w. St Ry Rev—March 15, 1902. No. 47020 C.

Sheiks Island Power Plant. F. H. Leonard, Jr. Detailed description. 1800 w. Elec Rev, N. Y—March 1, 1902. No. 46560.

The Hydraulic Equipment of the Colgate Power House. An illustrated detailed description of the Risdon wheels and governors, by Thomas J. Barbour, with reference also to other features. 5000 w. Jour of Elec—Jan., 1902. No. 46615.

The Power Station of the Manhattan Railway, New York. An illustrated detailed description of the electric power station for the elevated system in New York. 5300 w. Ir Age—March 13, 1902. No. 46874.

The Stations of the Independent Electric Light and Power Co., San Francisco, Cal. Illustrated description of a large electric central station in which oil is used exclusively for the generation of heat in the boiler furnace. 1500 w. Power—March, 1902. No. 46687.

Regulation.

Armature Interference and Brush Position. H. M. Hobart. Showing the influence of armature windings, and brush position upon regulation, and giving a table of useful observations to be taken on a commutating dynamo to determine the most favorable fixed brush position for a given machine. 1800 w. Elec Rev, Lond —Feb. 28, 1902. Serial. 1st part. No. 40717 A.

Sub-Station Equipment.

Influence of Sub-Station Equipment on the Cost of Electricity Supply. Andrew Stewart. Part of a paper read before the Newcastle Sec. of the Inst. of Elec Engrs. Discusses types of sub-stations and their equipment and present methods of distribution, giving results of investigations. 4800 w. Elect'n, Lond—Feb. 21, 1902. No. 46586 A.

Switchgears.

The Construction of High Tension Central Station Switchgears, with a Comparison of British and Foreign Methods. Henry W. Clothier. Read before the Manchester Soc. of the Inst. of Elec. Engrs. Brief outline of switchgear practice for alternating currents, and illustrates the main features of the apparatus produced in Germany as compared with English productions. Ill. 2400 w. Elec Times—Feb. 20, 1902. Serial. 1st part. No. 46577A.

Transformers.

Types of Transformers. John H. Ryan, Jr. An illustrated article explaining the systems of transmission of high-voltage currents and the transformers in use. 3500 w. Engr, U S A—March 15, 1902. No. 47005.

University Plant.

Power Plant and Heating System of the Ohio State University, Columbus. W. C. McCracken. Illustrated description of the system for heating, lighting and power distribution for a number of buildings. 2000 w. Engr, U S A—March 15, 1902. No. 47004.

The Power, Lighting and Heating Plant of the University of Chicago. Illustrated description of an installation of tubular boilers of 1,350 h. p., with an elaborate auxiliary equipment and a unique system of tunnels for the heating and electric lines. 5100 w. Eng Rec—March 15, 1902. No. 46881.

HEATING AND WELDING.

Electric Furnaces.

Electric Furnaces. Bertram Blount. Abstract of a paper read before the Manchester Sec. of the Inst. of Elec Engrs. An illustrated article describing the types and reviewing the history and development. 5500 w. Mech Engr, Lond—March 15, 1902. No. 47063 A.

Electrical Resistance Furnaces. Extract from an article by Otto Vogel, appearing in a German paper. Discusses the resistance furnace. 1300 w. Elec Rev, Lond—March 14, 1902. No. 47072 A.

LIGHTING.

Arc Lamps.

The Heany Enclosed Arc Lamp. E. Trier. Illustrated description with a statement of the points of excellence claimed. 1400 w. Elec Wld & Engr—March 8, 1902. No. 46785.

The Theory of the Regina Enclosed Arc Lamp (Zur Theorie der Regina-Dauerbrand-Bogenlampe). Dr. B. Donath. An illustrated account of photometric and photographic investigations, with explanation of the high actinic power of this lamp. 800 w. Elektrotech Zeitschr—March 13, 1902. No. 46961 B.

Canal Lighting.

Power Transmission Plant for Lighting the Cornwall Canal, Canada. An illustrated article describing an installation of American apparatus. 2000 w. Elec Wld & Engr—March 1, 1902. No. 46622.

Enclosed Arc.

Note on the Spectrum of the Enclosed

We supply copies of these articles. See page 319.

Arc. William Lincoln Smith. Comparisons showing the remarkable differences in light distribution between the light of the sky and that from the enclosed arc, and the Nernst lamp. 700 w. Elec Wld & Engr—Feb. 22, 1902. No. 46513.

Illumination.

Methods of Illumination. Louis Bell. Discusses the important qualities for a perfect illuminant, general illumination, &c., considering the practical rather than the technical side. 9300 w. Trans Am Inst of Elec Engrs—Feb., 1902. No. 46654 D.

Military.

See Mechanical Engineering, Automobiles.

Nernst Lamp.

Nernst Lamp, 1902 Model (Nernstlampe Model 1902). Illustrated description of details of the latest Nernst lamps manufactured by the Allgemeine Elektrizitäts-Gesellschaft, of Berlin. 600 w. Elektrizität—Jan. 18, 1902. No. 47197 C.

Osmium Lamp.

The Osmium Incandescent Lamp (Die Osmium-Glühlampe von Freiherr Auer v. Welsbach). From a paper by Robert Gabriel before the Elektrotechnischer Verein, Vienna, giving an account of the manufacture of electric lamps with osmium filaments, made by Dr. Auer von Welsbach, and experiments showing high efficiency. 1200 w. Elektro-Techniker—Jan. 15, 1902. No. 47199 B.

MEASUREMENT.

Phase Difference.

An Exact Method for Measuring Very Large Phase Differences (Eine Methode zur Exakten Messung Sehr Grosser Phasenverschiebungen). Dr. Max Breslauer. From the *Zeitschrift für Elektrotechnik* An illustrated description of a modification of the "three-voltmeter" method, in which only a differential galvanometer is used, with very exact results. 2500 w. Elektrotech Zeitschr—March 13, 1902. No. 46962 B.

Testing.

Testing by Resistance Measurements. Considers the tests made in central stations and the methods used. Ill. 2200 w. Cent Station—March, 1902. No. 46751.

Testing Materials.

The Testing of Materials (Prüfung von Materialien). Dr. Paul Holitscher. An account of methods and results of testing all kinds of materials used at the electrical works of W. Lahmeyer & Co. Diagrams and tables. Serial. 2 parts. 8000 w. Elektrotech Zeitschr—Feb. 20, 27, 1902. No. 46949 each B.

Wattmeters.

Rating of Wattmeters for Three-Phase Systems. Charles Brandeis. On means of determining correct ratings. 800 w. Elec Wld & Engr—March 15, 1902. No. 47009.

Test Coils for Alternating-Current Wattmeters. R. Beattie. A suggestion of a simple addition to a wattmeter which would make it in a certain sense self-testing. Explanatory. 1200 w. Elect'n, Lond —March 14 1902. No. 47073 A.

POWER APPLICATIONS.

Electric Motors.

A Device for Synchronizing Motors. William Duane. Illustrated description of a device for synchronizing two electric motors under stated conditions. 1300 w. Elec Rev, N. Y—March 15, 1902. No. 46897.

Early Forms of Electric Motors. Illustrated descriptions of the motors designed by Page, Davenport and Hjorth, about the middle of the nineteenth century. 800 w. Sci Am Sup—March 22, 1902. No. 47117.

Mine Hoisting.

A New System of Electric Hoisting for Mine Shafts (Ueber ein Neues System Elektrischer, Schacht-Fördermaschinen). Hans Bansen. A description of a system in which the hoisting motor is in circuit with a dynamo driven by an auxiliary motor, by which means the speed is regulated. 800 w. Glückauf—Feb. 22, 1902. No. 46979 B.

Mining.

Electricity in Mining. George H. Gibson. On electrical machinery used in mining, with report of a number of recent installations. Ill. 2700 w. Eng & Min Jour—March 1, 1902. No. 46641.

Power Plant.

Electric Power in a Shale Oil Works. Brief description of an installation of exceptional interest about to be put down at the works of the Oakland Oil Company, in Scotland. 1200 w. Elec Rev, Lond—March 7, 1902. No. 46854 A.

TRANSMISSION.

High Tension.

High-Tension Electric Power Transmission. Geo. H. Gibson. A discussion of the extent to which high-tension transmission enters as a factor in the utilization of natural forces, with illustrations from important installations. 3500 w. Engineering Magazine—April, 1902. No. 47186 B.

Lightning-Arresters.

Horn Lightning-Arresters with Iron Framing. Eugen Klein. Illustrated description of lightning safety devices for electrical apparatus. 900 w. Elect'n, Lond —March 7 1902. No. 46851 A.

Long Distance.

The Longest Power-Transmission in the World. Thomas Commerford Martin. An

illustrated article giving much interesting information in regard to the allied Bay Counties Power and Standard Electric companies of California. 3600 w. Rev of Revs—March, 1902. No. 46516 C.

Mexico.

The Transmission System of the Compania Explotadora De San Ildefonso of the City of Mexico. Stephen Q. Hayes. An illustrated description of a remarkable system where a number of generating stations supply power to a single sub-station. 3000 w. Elec Wld & Engr—March 15, 1902. No. 47006.

MISCELLANY.

Electric Shock.

Electric Shock and Legislation Thereon. C. E. Webber. Concerning the scientific aspect, liability to exposure, and legislation. 5800 w. Inst of Elec Engrs—Feb. 27, 1902. No. 46676 D.

Electric Shocks at Five Hundred Volts. Alexander Pelham Trotter. Records a few experiments and discusses the conditions under which shocks at 500 volts are devoid of danger. 4000 w. Inst of Elec Engrs—Feb. 27, 1902. No. 46675 D.

Electric Shocks. F. B. Aspinall. Discusses points on which information is desired, in the hope of learning better methods of giving aid in case of accident. 5000 w. Inst of Elec Engrs—Feb. 27, 1902. No. 46674 D.

Liverpool.

The Rapid Progress of Electricity in Liverpool. Abstracted from a report submitted by A. B. Holmes. Gives much information relating to supply and cost. 2000 w. Elec Engr, Lond—Feb. 28, 1902. No. 46715 A.

Russian Congress.

The Second Congress of Russian Electrical Engineers at Moscow (Der II. Kongress Russischer Elektrotechniker in Moskau). C. v. Vetterlein. A general review of the congress, held in January, 1902, and of the papers read there. 2000 w. Elektrotech Zeitschr—Feb. 27, 1902. No. 46953 B.

Theory.

The Scientific Foundations of Electrical Engineering (Die Wissenschaftlichen Grundlagen der Elektrotechnik). Prof. Max Reithoffer. An illustrated lecture on the fundamentals of electricity and magnetism. 4500 w. Zeitschr d Oesterr Ing u Arch Ver—Special supplement, Feb. 14, 1902. No. 46941 B.

GAS WORKS ENGINEERING

Acetylene.

Acetylene for Railway Lighting in France. Information concerning the mixture of acetylene and cannel coal gas used in lighting the coaches of the Paris-Lyons-Mediterranean Ry. 1000 w. Engr, Lond—March 14, 1902. No. 47075 A.

Some Disastrous Acetylene Gas Explosions. An account of two explosions, wrecking the houses in which they occurred, and causing loss of life. Ill. 500 w. Sci Am—March 22, 1902. No. 47113.

Address.

Mr. Charles Hunt's Presidential Address before the Midland Association of Gas Managers. Interesting discussion of matters relating to the gas industry. 10000 w. Gas Wld—March 1, 1902. No. 46713 A.

Bench Firing.

Coal for Bench Firing. R. C. Cornish. Read before the Wisconsin Gas Assn. An account of methods used at Racine, Wis. 1000 w. Pro Age—March 15, 1902. No. 46822.

Carburetted Air.

Carburetting Air for Lighting Purposes. Reviews what has been done by the French Aërogen Gas Company, in the direction of the practical application of carburetted air for the purpose of illumination. Ill. 2100 w. Jour Gas Lgt—March 18, 1902. No. 47149 A.

Chimneys.

The Control of Chimney Draught. E. H. Hudson. Read before the Manchester Dist. Inst of Gas Engrs. Discussion of the design of chimneys in connection with retort-house work, and the difficulties due to draught. Ill. 4500 w. Jour Gas Lgt—March 4, 1902. No. 46841 A.

Coal Gas.

Coal Gas Treatment. A. B. Slater, Jr. Read before the New England Assn. of Gas Engrs. Discusses results of various methods, with special reference to the deposition of naphthaline. 2300 w. Pro Age—March 15, 1902. No. 46821.

New Comparisons in Favor of Coal Gas. T. E. Pye. Concerning the relative hygienic values of coal gas and electricity respectively as illuminating and heating agents. 2000 w. Jour Gas Lgt—March 11, 1902. No. 47065 A.

Coal Shed.

A Model Coal Shed. Thomas H. Hintze. Read before the New England Assn. of Gas Engrs. An illustrated description of a new structure of the Lowell (Mass.) Gas Light Company. 3300 w. Am Gas Lgt Jour—March 17, 1902. No. 46896.

We supply copies of these articles. See page 319.

Coke.

The Disposal of Coke. W. Whatmough. Read before the Manchester Dist. Inst. of Gas Engrs. Discusses the trade situation due to decrease in prices obtained for coke, and the remedy. General discussion follows. 4500 w. Jour Gas Lgt—March 4, 1902. No. 46842 A.

Distribution.

Distributing Artificial Gas at High Pressure in a Suburban Locality. George F. Goodnow. Read before the New England Assn. of Gas Engrs. Also discussion. Describes the methods used by the North Shore Gas Company of Illinois. Ill. 6000 w. Am Gas Lgt Jour—March 3, 1902. No. 46623.

Explosive Limits.

Explosive Limits of Combustible Gases. Dr. P. Eitner. Abstract translation of a series of five articles in recent numbers of the *Journal für Gasbeleuchtung*. A review of researches and results. 3000 w. Jour Gas Lgt—March 11, 1902. Serial. 1st part. No. 47068 A.

Gasholders.

Standard Specifications for Supplying the Structural Ironwork of Gasholders. Drawn up in 1901, conjointly by the German Assn. of Gas and Water Engrs. and the Union of German Mfrs. of Gasholders. 2500 w. Jour Gas Lgt—March 11, 1902. No. 47069 A.

High-Pressure.

High-Pressure Gas Lighting. Joseph Nasmith. Extracts from a paper read before the Manchester Assn. of Engrs. Discusses the recent improvements in the gas industry, especially incandescent lighting, and high pressure, or intensified gas lighting. Also general discussion. 6200 w. Jour Gas Lgt—Feb. 25, 1902. No. 46663 A.

Incandescent Lighting.

The Variability of the Incandescent Gas Light (Die Launen des Gasglühlichts). A discussion of the variability of the light, and the possibility of properly regulating the burner. 1000 w. Gesundheits Ing—Jan. 31, 1902. No. 47195 B.

Mantles.

The Theory of the Incandescent Mantle. A. H. White, H. Russel, A. F. Traver. Read at meeting of Mich. Gas Assn. Discusses the cause of luminosity of the mantle, quoting from other investigations, and giving results of experiments of temperature measurements, and a statement of the writers' views. 3800 w. Pro Age—March 15, 1902. No. 46820.

Orleans Tramway Plant.

See Street and Electric Railways.

Petroleum.

Mineral Oil as an Illuminant. Vivian B. Lewes. Abstract of the first of a course of three lectures delivered at the Petroleum Inst., London. The present lecture deals with the use of oil in lamps. 1700 w. Gas Wld—March 15, 1902. Serial. 1st part. No. 47062 A.

Pipes.

A Twin Pipe. R. J. Melbourne. Illustrated description of a pipe of oval shape, divided into two parts, each part having the same capacity as a single pipe. Discusses the advantages and economy secured. 1800 w. Jour Gas Lgt—March 4, 1902. No. 46838 A.

Producer Gas.

The Use of Producer Gas in Engineering. Extracts from paper by F. J. Rowan, read at meeting of the Inst. of Engrs. in Scotland. Considers producers with water bottoms, the furnaces which are specially useful to engineering and shipbuilding, the use of producer gas in gas-engines, &c. 3500 w. Jour Gas Lgt—Feb. 25, 1902. No. 46664 A.

Retorts.

Inclined Retorts and Their Working. H. P. Maybury. Read before the Midland Assn. of Gas Mgrs. Also discussion. A paper favoring the use of inclined retorts, discussed by those who had had no experience with them. 9400 w. Jour Gas Lgt—March 4, 1902. No. 46840 A.

Retort-House Working in Berlin. Edward Drory. Tabulated results of actual workings with explanatory remarks, showing the advantage of inclined retorts. 1600 w. Jour Gas Lgt—Feb. 25, 1902. No. 46661 A.

The Early History of Inclined Retorts. A summary of the history, which does not date back more than twenty years. 2000 w. Jour Gas Lgt—Feb. 18, 1902. Serial. 1st part. No. 46536 A.

Ventilation.

A Scheme of Ventilation with Gas-Warmed Air. Suggests that forced ventilation be accompanied by an arrangement for warming the inflowing air by means of pipes or plates heated by gas. 1800 w. Jour Gas Lgt—Feb. 25, 1902. No. 46659 A.

Water Gas.

Some Details in the Operation of a Water Gas Plant. Charles F. Leonard. Notes points that have appealed to the writer in a comparatively brief experience in gas-works using the Lowe process. Also discussion. 9500 w. Am Gas Lgt Jour—March 24, 1902. No. 47120.

The Building of a Water Gas Plant. C. W. Tippy. Read at meeting of the Mich. Gas Assn. Illustrates and describes a plant recently built in Detroit. 4000 w. Am Gas Lgt Jour—March 10, 1902. No. 46758.

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INDUSTRIAL ECONOMY

Business Preparation.

The Commercial Side of Engineering. Charles Kirchhoff. A lecture to students showing the need of commercial training as well as mechanical, to carry to a successful issue the undertakings of engineering works. 4500 w. Sib Jour of Engng—Feb., 1902. No. 46653 C.

Chemical Industries.

Engineering in the Chemical Industries. R. H. Thurston. On the value of a knowledge of chemistry in connection with mechanical engineering. 7200 w. Sib Jour of Engng—Feb., 1902. No. 46652 C.

Coal Supremacy.

Our Coal Supremacy and Its Significance. Edwin Moxey. Discusses the relation of fuel supply to progress as a nation. 3200 w. Sci Am Sup—March 15, 1902. No. 46813.

Commerce.

Russia and America in the Near East. Alexander Hume Ford. Discusses railroad building for commercial purposes, and other measures for securing trade. 4000 w. Ir Age—March 20, 1902. No. 46898.

Education.

Technical Education vs. Shop Education. Egbert P. Watson. Arguments favoring the latter. 2300 w. Ir Age—March 20, 1902. No. 46899.

The Place of the Mechanical Laboratory in the Education of the Engineer. Prof. J. Boulvin. A discussion of the great value of an intelligently conducted mechanical laboratory in the technical school. 4500 w. Engineering Magazine—April, 1902. No. 47184 B.

Factory Office.

The Factory Office Considered as a Productive Department. Kenneth Falconer. The first of a series of papers dealing with the factory office, and its functions in connection with modern works management methods. 2000 w. Engineering Magazine—April, 1902. No. 47185 B.

Government Aid.

Government Aid to Mining. A number of discussions communicated in advance of the meetings of the Canadian Mining Institute. 13700 w. Can Min Rev—Feb. 28, 1902. No. 46626 B.

India.

The Industrial Development of India. Nilkanth B. Wagle. Discusses plans proposed for future work in developing the industrial resources. Followed by general discussion. 17700 w. Jour Soc of Arts—March 14, 1902. No. 47059 A.

Industrial Methods.

British vs. American Methods of Construction. Extract from an article by D. N. Dunlop, in the *Nottingham Guardian*, relating primarily to the Westinghouse Electric Works at Manchester, but involving questions which affect the entire industrial situation of Great Britain. 1000 w. U S. Cons Repts. No. 1289—March 14, 1902. No. 46746 D.

Labor.

Attitude of Courts Toward Labor Interference. Articles by James A. Miller and Arthur E. Ireland. The first article encourages resort to the courts; the second discusses present laws affecting strikes, and related matters. 4200 w. Mod Mach—March, 1902. No. 46665.

The Eight-Hour Bill. Testimony of A. C. Dinkey and Judge L. E. Payson before the House Committee on Labor, opposing the passage of the bill. 4500 w. Ir Age—March 6, 1902. No. 46605.

Theory of Compensation of Labor. A discussion of the proper way to introduce piecework systems in railroad shops. 1600 w. Am Engr & R R Jour—March, 1902. Serial. 1st part. No. 46542 C.

Pensioning.

The Pension System and Profit Sharing. J. B. Johnston. Discusses the growing sentiment in favor of pensions to the invalided or superannuated workmen; also the subject of profit sharing, which the writer does not think an unqualified success. 1600 w. Am Mfr—Feb. 27, 1902. No. 46538.

Premium Plan.

The Premium Plan of Paying for Labor. F. A. Halsey. An explanation of this system and a discussion of its advantages and disadvantages. 7000 w. Sib Jour of Engng—March, 1902. No. 47055 C.

Trade Unions.

The Possibilities of a New Trade Unionism. Percy Longmuir. Discussing modern industrial conditions in connection with labour relations, showing that interested co-operation is the true motive for association. 3000 w. Engineering Magazine—April, 1902. No. 47187 B.

Works Management.

Money-Making Management for Workshop and Factory. C. U. Carpenter. Mr. Carpenter's third paper discusses and classifies the various productive departments, prior to examining their functions in detail. 2000 w. Engineering Magazine—April, 1902. No. 47181 B.

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MARINE AND NAVAL ENGINEERING

Battleships.

H. M. S. Queen. Plan and description of this new British ship, its armor and equipment. 2000 w. Engr, Lond—March 7, 1902. No. 46865 A.

Our New Battleships. Editorial on the new British battleships Queen, Prince of Wales, and King Edward VII. 1700 w. Engng—March 7, 1902. No. 46858 A.

Repairs to the Battleship "Oregon" at the Puget Sound Navy Yard. Illustrates and describes the method of making of extensive repairs to the keel and bottom of this heavy vessel, which was damaged by striking an uncharted rock in Chinese waters. 2000 w. Eng News—March 13, 1902. No. 46800.

The New English Battleship Type "King Edward VII." From *Illustrirte Zeitung*. Illustrated description of a new type of warship, and its equipment. 800 w. Sci Am Sup—March 15, 1902. No. 46814.

The Russian Battleship "Pobieda." Compares this vessel with some other ships of her displacement, giving the principal details of the vessel, and remarks on the class to which she really belongs. Ill. 1800 w. Engr, Lond—Feb. 28, 1902. No. 46733 A.

Boilers.

See Mechanical Engineering, Steam Engineering.

British Navy.

Engineer Officers for the Fleet. Rollo Appleyard. Discusses the question of obtaining sufficient number of men qualified for the engineering duties. 2500 w. Elec Rev, Lond—Feb. 21, 1902. No. 46581 A.

Cruisers.

His Imperial German Majesty's Cruiser "Vineta." Richard Inch. Describes the main engines, auxiliary machinery, boilers, &c. Ill. 3800 w. Jour Am Soc of Naval Engrs—Feb., 1902. No. 47053 H.

The Armored Cruiser "Good Hope." Interesting illustrated description of this vessel which has just satisfactorily completed her official contract steam trials. 3800 w. Engng—Feb. 28, 1902. No. 46728A.

Destroyer.

Contract Trial of the Torpedo-Boat Destroyer "Decatur." H. Webster. Illustrated detailed description of the vessel and its equipment, with report of trial. 2000 w. Jour Am Soc of Naval Engrs—Feb., 1902. No. 47048 H.

Docking.

Docking of Ships. Theodore Lucas. Describes graving docks, floating docks, and marine railways, considering the advantages of each, and discussing blocking and all the arrangements in docking. 2200 w. Naut Gaz—March 13, 1902. No. 46819.

Dry Dock.

Test of the New Floating Dry-Dock at Algiers, La. Frederick Moore. A brief account of this dock and its test by the battleship "Illinois." 600 w. Sci Am—March 8, 1902. No. 46692.

Economy.

The Growth of Economy in Marine Engineering. W. M. McFarland. Mr. McFarland's second paper deals with the introduction of higher steam pressures and the development of the compound engine. 3500 w. Engineering Magazine—April, 1902. No. 47183 B.

"Hohenzollern."

Below Decks on the "Hohenzollern." An illustrated article especially describing the mechanical equipment. 1200 w. Sta Engr—March, 1902. No. 47012.

Hull Protection.

The Protection of the Hulls of Iron Ships (Comment on Peut Proteger les Coques des Navires en Fer). From the *Chemiker Zeitung*. A brief review of sheathing and protective paints, particularly the Rahtjen composition. 900 w. Rev Technique—March 10, 1902. No. 47164 D.

Hulls.

Deformation and Resistance of the Hulls of Vessels with Transverse Forces (Déformation et Resistance des Coques de Navire à la Flexion Transversale). H. Chaigneau. A mathematical discussion of the transverse stresses and strains of hulls under various circumstances. Serial. 1st part. 4000 w. Rev Technique—Feb. 25, 1902. No. 47163 D.

Liners.

The New Liners of the French General Transatlantic Company. Two-page plate, illustrations, and description of the two new liners, "Lorraine" and "Savovie," for service between France and New York. 800 w. Engng—March 14, 1902. No. 47081 A.

Mail Steamers.

The "Kronprinz Wilhelm." Illustrated description of this high-speed Atlantic liner. 1000 w. Sci Am Sup—March 15, 1902. No. 46812.

Marine Engines.

Results of Investigations on Recent Engines of the German Navy. Chief Naval Constructor Köhn von Jaski. From *Schiffbau*. Translation. Investigations into the de-

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gree of uniformity of the stresses on the shafts in the new vessels, with other facts necessary to judge of the efficiency of the engines. 3800 w. Jour Am Soc of Naval Engrs—Feb., 1902. No. 47046 H.

The Balance of a Four-Cylinder, Triple Expansion Marine Engine. Harvey D. Williams. An investigation of the possible causes of vibration in a marine engine of a type quite generally used. Ill. 2800 w. Jour Am Soc of Naval Engrs—Feb., 1902. No. 47050 H.

Marine Machinery.

Notes on Details of Construction and Arrangement of Marine Machinery. Emil Theiss. Calls attention to details of construction often slighted. Results of observations and experience on the battleships Alabama and Kearsarge. 6500 w. Jour Am Soc of Naval Engrs—Feb., 1902. No. 47045 H.

Motor-Boats.

An International Motor-Boat Exhibition at Berlin. An account of an exposition to be opened June first, near Berlin, which contemplates a display of the best that has been achieved in all countries in respect to the construction, care and use of boats, launches, yachts, and craft propelled by gas, gasoline, electrical or steam motors. 800 w. U S Cons Repts, No. 1290—March 15, 1902. No. 46870 D.

Naval Development.

Naval Development During the Next Decade. George W. Melville. Discusses reasons why the United States should have her navy increased, and improvements needed. 3300 w. Sci Am Sup—Feb. 22, 1902. No. 46502.

Seaworthiness.

"Seaworthiness." B. Goldsmith. Discusses the importance to passengers, and also to underwriters, of the seaworthiness of vessels, especially for long voyages. 10500 w. Aust Min Stand—Jan. 23 & 30, Feb. 6, 1902. 3 parts. No. 46868 each B.

Shipbuilding.

Notable Shipbuilding Abroad. Mainly a review of this industry in the United States, with notes also on Germany and Holland. 1400 w. Engr, Lond—Feb. 21, 1902. No. 46601 A.

The Eastern Shipbuilding Company. Gives an account of the organization of this company, and an illustrated description of its plant, and the equipment. 3000 w. Marine Engng—March, 1902. No. 47001 C.

Signals.

Sound Signals. E. Price-Edwards. A review of experiments made with fog-signals and a discussion of the many difficulties met. 12600 w. Jour Soc d Arts—March 7, 1902. No. 46843 A.

Stability.

Variations in Initial Stability (Variazioni della Stabilita Iniziale). R. Levati. Discussing the changes in stability in the case of the filling of one or more compartments. 2000 w. 2 plates. Rivista Marittima—Feb., 1902. No. 47189 G.

Steam Cutters.

Standard Steam-Cutter Machinery for the U. S. Navy. A. M. P. Maschmeyer. Describes the fixed types, gives particulars of a trial, with indicator diagrams, with tables of dimensions of engines, boilers, &c., and their weights. 1100 w. Jour Am Soc of Naval Engrs—Feb., 1902. No. 47047 H.

Steamships.

Handsome New Coasting Steamship. Illustration, with description of the "Spokane" for the merchant marine of the Pacific coast. 1500 w. Naut Gaz—March 13, 1902. No. 46818.

Lake Built Ocean Tramp Steamers. Charles C. West. Illustrates and describes the design and construction of the "Minnetonka" and "Minnewaska" which are to be cut in two and towed to Montreal and there re-united. 2000 w. Marine Engng—March, 1902. No. 47002 C.

New Combination Ferry and Excursion Steamer. Illustration and description of a boat under construction for service on the Detroit River. 2800 w. Naut Gaz—Feb. 27, 1902. No. 46616.

Stern Frame.

See Mechanical Engineering, Machine Works.

Trials.

Progressive Trials of U. S. Battleships. Report concerning the progressive trials of the "Alabama," "Massachusetts," and "Kearsarge," held on the Barren Island course, in Chesapeake Bay. 4800 w. Jour Am Soc of Naval Engrs—Feb., 1902. No. 47052 H.

Yachts.

High-Speed Twin-Screw Yacht "Vixen." Illustrated description of a private yacht built for service of the owner principally between Tarrytown and New York. 800 w. Sci Am—March 1, 1902. No. 46550.

Steering Gear of the Yacht "Meteor." Brief illustrated description of the novel steering gear designed especially for the Emperor's new yacht. 500 w. Eng News—Feb. 27, 1902. No. 46568.

The Building Season of 1901-2. W. P. Stephens. The progress of designing and the work of the yards are discussed. Plans of vessels are given. 4500 w. Rudder—March, 1902. No. 46755 D.

The Emperor's Yacht "Meteor III." Illustration, with interesting information concerning this, and other yachts owned by the Emperor. 1200 w. Sci Am—March 1, 1902. No. 46548.

We supply copies of these articles. See page 319.

MECHANICAL ENGINEERING

AUTOMOBILES.

Acceleration.

Acceleration of Automobiles. L. M. Aspinwall. Considers means of determining the power necessary to accelerate a vehicle of a given weight. 1300 w. Horseless Age—March 12, 1902. No. 46892.

Brakes.

New Brakes for Automobiles. From *La Locomotion.* Illustrates and describes new braking apparatus exhibited at the recent Paris Automobile Show. 700 w. Sci Am Sup—March 1, 1902. No. 46558.

Charging Batteries.

Single-Phase Permutator with Revolving Brushes. P. Letheule. Illustrates and describes an apparatus designed for the purpose of charging automobile storage batteries from a single-phase distributing system. 500 w. Elec Wld & Engr—March 15, 1902. No. 47007.

Cycle Design.

Design for an Electric Motor Cycle. J. C. Brocksmith. Illustrated detailed description of a design for use particularly in cities. The present article describes the frame. 2300 w. Am Elect'n—March, 1902. Serial. 1st part. No. 46678.

Electric Vehicles.

Recuperative Braking on Electric Vehicles. W. A. Th. Mueller, in *Centralblatt fuer Accumulation Elementen und Accumobilenkunde.* A discussion of means of getting the greatest possible mileage out of a given battery, compound winding, general principles, &c. 1500 w. Horseless Age—March 26, 1902. Serial. 1st part. No. 47143.

English Daimler.

Le Chat Noir. Illustrates and describes what is considered the finest machine yet made by this company. 700 w. Autocar—March 1, 1902. No. 46709 A.

Exhibition.

Crystal Palace Show. An illustrated article giving particulars of the leading features, exhibits, and novelties. 5800 w. Auto Jour—March 15, 1902. No. 47126 A.

Exhibits.

Exhibits at the Coliseum. Brief illustrated descriptions of automobiles and accessories at the automobile show in Chicago, March 1 to 8. 5400 w. Auto Topics—March 1, 1902. No. 46632 C.

Feed Regulation.

The Automatic Feed Regulation of Steam Vehicle Boilers. J. Edward Baldwin. Reviews the existing situation, showing what is desirable and undesirable in the construction and operation of these devices. 1000 w. Horseless Age—March 5, 1902. No. 46667.

Gasoline Motors.

The Starting of Gasoline Motors. Albert L. Clough. Notes improvements which have increased the popularity of gasoline vehicles, and offers some suggestions for self-starters. 1100 w. Horseless Age—March 19, 1902. No. 47013.

Gasoline Vehicles.

A Novel Air-Cooled Gasoline Motor. An illustrated description of the Balzar revolving cylinder air-cooled gasoline motor. 1200 w. Sci Am—March 1, 1902. No. 46547.

Gasoline Automobiles—1902 Models. Illustrations with brief descriptions of several of the recent designs. 2200 w. Sci Am—March 1, 1902. No. 46549.

Suggestion for a Gasoline Tank Fitting. Robert G. Pilkington. Calls attention to points needing to be improved. 1000 w. Horseless Age—March 5, 1902. No. 46668.

The Duryea Gasoline Carriage. Illustrated detailed description of the Duryea three-wheeled phaeton. 1300 w. Sci Am—March 1, 1902. No. 46553.

The Packard Gasoline Touring Car. Illustrated detailed description. 2000 w. Sci Am—March 1, 1902. No. 46552.

Ignition.

Evolution in Jump Spark Plug Construction. Hugh D. Meier. Considers the requirements, principle and detail construction, material, &c. Ill. 1300 w. Horseless Age—March 12, 1902. No. 46893.

Ignition Devices for Gas and Petrol Motors. S. R. Bottone, in the *English Mechanic.* Brief notes on the more important devices in use for this purpose, with remarks on their fitness or unfitness for certain requirements. 1400 w. Sci Am Sup—March 22, 1902. No. 47118.

Ignition Faults. Reginald Wales. Discusses the four vital features: the batteries; the transmission wires; the induction coils; and the sparking points. 1500 w. Auto Topics—March 22, 1902. No. 47044.

Industrial Vehicles.

Industrial Motor Cars in France. An illustrated article explaining the development of the motor car industry in France, and giving much information in regard to places where successful service of heavy vehicles has been established, considering the types used, motive power, &c. 3800 w. Engr, Lond—Feb. 28, 1902. No. 46730 A.

We supply copies of these articles. See page 319.

Light Carriages.

The Eight Horse Power Clement Carriage. From *La Locomotion.* Illustrated description of an 8 horse power double cylindered light carriage. 4000 w. Horseless Age—March 19, 1902. No. 47014.

Military.

Electric Lighting and Automobiles in Military Operations (Elektrische Beleuchtung und Maschinenfahrzeuge im Landkriege). Maj. Gen. F. Otto. An article showing the great advantages of electric lighting and steam vehicles for traction and power purposes in warfare. 2000 w. Zeitschr d Ver Deutscher Ing—March 8, 1902. No. 46927 D.

Motor Cycles.

Some Motor Cycles at the Crystal Palace. A. J. Wilson. Illustrations and brief descriptions of interesting exhibits. 3000 w. Autocar—Feb. 22, 1902. No. 46579 A.

Motor Vehicles.

A Successful and Interesting Automobile. Alexander F. Sinclair. An illustrated description of a vehicle made in Birmingham, England. 2300 w. Auto Mag—March, 1902. No. 46517 C.

Non-Freezing Liquids.

Non-Freezing Liquids for Cylinder Jackets. E. E. Keller. An account of experiments with calcium chloride solutions. 1700 w. Autocar—March 8, 1902. No. 46845 A.

Serpollet System.

The Serpollet System. A brief description of the main features of these steam cars. Ill. 1200 w. Autocar—March 8, 1902. No. 46844 A.

Steam Carriages.

The Lane Steam Carriage. An illustrated description of a very successful carriage, especially noting its novel features. 1200 w. Sci Am—March 1, 1902. No. 46545.

The Overman Steam Automobile. Illustrated detailed description. 1000 w. Sci Am—March 1, 1902. No. 46546.

The White Steam Carriage. Illustrated detailed description of the 1902 model. 1800 w. Sci Am—March 1, 1902. No. 46544.

Steering.

Steering Gears for Automobiles. Hermann Lemp. Shows the importance of a properly designed steering gear, its requirements, &c., with discussion of the lever and the wheel, and of the hydraulic steering check. 2000 w. Horseless Age—Feb. 25, 1902. No. 46507.

Trolley Automobile.

Traction by Trolley Automobile (Traction par Trolley Automoteur). Jean Loubat. An illustrated account of omnibus lines in which the vehicle runs on ordinary roads and is operated by an electric motor which gets its current from double trolley wires overhead, on which a small automotor trolley travels. 2800 w. Rev Technique—Feb. 25, 1902. No. 47162 D.

Traction by Overhead Motor Trolley. From *La Revue Technique.* Illustrated description of the leading features of the Lombard-Gérin system, in which the electric energy is supplied to the vehicle from two aërial wires. 1500 w. Engr, Lond—March 14, 1902. No. 47079 A.

HYDRAULICS.

Centrifugal Pumps.

High Pressure Centrifugal Pumps Driven by Electric Motors or Steam Turbines (Pompes Centrifuges à Haute Pression avec Moteurs Electriques et Turbines à Vapeur). A. Rateau. Illustrated description, with results of tests. 3000 w. Génie Civil—Feb. 15, 1902. No. 46997 D.

High-Speed Centrifugal Fans and Pumps. Summary of a paper by M. A. Rateau, published recently in the *Bulletin de la Société de l'Industrie Minérale.* Describes fans and pumps driven by steam turbines and electromotors for high pressures. 1800 w. Engr, Lond—March 7, 1902. Serial 1st part. No. 46862 A.

Pumping Plant of the Skinner Dry Dock, Baltimore, Md. Illustrated description of the centrifugal pumping plant with a capacity of 150,000 gallons per minute. 2300 w. Eng Rec—March 22, 1902. No. 47037.

See also Mechanical Engineering, Miscellany.

Keokuk, Iowa.

A Proposed Dam and Water Power on the Mississippi River at Keokuk, Iowa. Lyman E. Cooley. A general account of the proposed work with a statement of the conditions, and general discussion. 5000 w. Jour W Soc of Engrs—Feb., 1902. No. 46702 D.

Meters.

See Civil Engineering, Water Supply.

Mine Pumps.

See Mining and Metallurgy, Mining.

Pumping Plant.

A Gas Engine Driven Direct Pressure Pumping Plant, with Some Experiments on Pump Valve Area. D. W. Mead. An illustrated outline of a plant installed at Winchester, Indiana, with account of experiments made. 6000 w. Jour W Soc of Engrs—Feb., 1902. No. 46703 D.

Pumps.

The Riedler "Express" Pump. Illustrated description of high-speed pumps.

We supply copies of these articles. See page 319.

1600 w. Engng—March 7, 1902. No. 46856 A.

Varieties and Principles of Pumps. T. W. Shelton. Briefly describes many varieties, explaining their advantages. 1400 w. Engr, U S A—March 1, 1902. No. 46672.

Turbines.

The 5500 Horse Power Turbines of the Niagara Falls Power Co. and their Hydraulic Governors (Die 5500 P. S. Turbinen der Niagara Falls Power Cie. und deren Hydraulische Regulatoren). A well illustrated description of this machinery, built by Escher Wyss & Co., of Zurich, for the 1900 extension of the power plant above the Falls. 1800 w. Schweiz Bauzeitung—Feb. 15, 1902. No. 46995 B.

MACHINE WORKS AND FOUNDRIES.

Armor.

Armor Plate Tools. Arthur Masters. Illustrates and describes the method of fitting armor and backing to warships. 1100 w. Mach, N. Y—March, 1902. No. 46774.

Boiler Making.

Modern Practice in Boiler-Making Shops. Egbert P. Watson. A comparison of the crude early methods with the efficient equipment of the modern boiler shop, richly illustrated from European and American practice. 3500 w. Engineering Magazine—April, 1902. No. 47182 B.

Boiler Plates.

Diagram for the Thickness of Boiler Plates. James A. Brown. Diagram, with explanatory notes. 500 w. Am Mach—Feb. 27, 1902. No. 46512.

Boring Mill.

Boring Mill (Tours Verticaux). G. Nardin. A well illustrated description of machine tools constructed by the Ducommun works at Mulhouse, Alsace. 1200 w. Génie Civil—Feb. 22, 1902. No. 47150 D.

Castings.

A Set of Tools for Machining a Cam. Joseph V. Woodworth. Illustrates and describes a set of tools for machining a repetition casting of unusual shape, which was used as a cam on an automatic machine for making fruit baskets. 700 w. Am Mach—March 20, 1902. No. 47100.

Methods of Continuous Casting and Rolling for Light Sections. Theodore J. Vollkommer. An illustrated article reviewing what has been done in the work of continuously casting and rolling steel, discussing the possibilities. 5600 w. Ir Trd Rev—March 20, 1902. No. 47095.

Two Fixtures for Finishing Cast Iron Segments. D. E. MacCarthy. Illustrated description. 400 w. Am Mach—March 6, 1902. No. 46686.

Dies.

A Quadruplicate, Automatic-Slide Die for Piercing Conical Shells. William Doran. Illustrates and describes a die designed for the economic production of a pierced brass shell which formed the draft regulator of a new burner of the "Bunsen" type. 1900 w. Am Mach—March 6, 1902. No. 46685.

Dr ll Press.

Multiple Drill Press (Der Serienbohrapparat). Wm. C. Wachholtz. An illustrated description of a multiple drill chuck which can be applied to any drill press, and used to drill holes in pipe flanges, cylinder heads, etc. 600 w. Technologist—Jan., 1902. No. 46913.

Economy.

Foundry Economy. Dr. Richard Moldenke. How the foundryman is to economize by the application of scientific methods is discussed, and other suggestions given. 2800 w. Jour Am Found Assn—April, 1902. No. 46521.

Factory Office.

See Industrial Economy.

Feed Gear.

A Self-Acting Feed Gear for Horizontal Boring Bars. C. Patterson. Shows a self-acting feed gear as applied to the 2-inch boring bars on a special multiple spindle horizontal boring machine. Ill. 600 w. Am Mach—March 13, 1902. No. 46888.

Hardening.

Combined Oil and Water Hardening of Taps, Milling Cutters, etc. John L. Bacon. Describes a method that seems not only to save time, but to give more satisfactory results than the ordinary method used. 1400 w. Am Mach—March 6, 1902. No. 46683.

Hardening Extra Long Stay-Bolt Taps. E. R. Markham. Directions for this work. 1600 w. Mach. N. Y—March, 1902. No. 46775.

Heating in Red Hot Lead for Hardening. E. R. Markham. Notes from experience on heating steel in the lead crucible. 900 w. Am Mach—March 6, 1902. No. 46681.

Heavy Work.

Hydraulic Device for Adjusting Heavy Work on Machine Tools. Illustration and description of a device applicable to large work to be machined where work is stationary and the cutting tools movable, the work having to be adjusted to the correct position for the cutting. 600 w. Am Mach—March 27, 1902. No. 47145.

Machine Tools.

Bevelling Machine. Illustrates and describes a machine for use by shipbuilders. 1400 w. Engr, Lond—March 14, 1902. No. 47077 A.

Pipes.

On Pipes and Pipe Threads. Engrav-

ings and remarks on the trouble caused by not following the standard proportions, suggesting that the name of the maker be stamped on the pipe with the quality of the material, and the pressure to which the pipe has been tested. 1800 w. Locomotive—Jan., 1902. No. 46604.

Premium Plan.

See Industrial Economy.

Pulleys.

A Cone Pullev Pattern. John M. Richardson. Illustrates and describes a method that requires no core except a stock core through the hub. 800 w. Am Mach—March 6, 1902. No. 46682.

Radiators.

European Radiators. Charles F. Hauss. Illustrated descriptions of types. 800 w. Met Work—March 15, 1902. No. 46816.

Screw Machine.

The Schmutz Automatic Screw Machine. Illustrates and describes a screw machine having no turret, and the tools are simple pieces of bar steel ground to shape at the ends, easily sharpened, and adjusted by a turn of a spanner. 1200 w. Engng—March 14, 1902. No. 47083 A.

Seamless Pipes.

The Manufacture of Large Boiler Flues and Heavy Seamless Pipes (Ueber Herstellung Grosser Kesselschüsse und Schwerer Nahtloser Rohre). Hr. Ehrhardt. An illustrated paper before the Verein Deutscher Eisenhüttenleute giving a description of methods of rolling hollow cylinders into pipes; with discussion. 2500 w. Stahl u Eisen—March 1, 1902. No. 46966 D.

Shrinkage.

Shrinkage and Pressure Joints. William Ledyard Cathcart. An illustrated discussion of practice in the various applications of this work. 10600 w. Sch of Mines Qr—Jan., 1902. No. 46798 D.

Shops.

New Shops of the Grant Tool Company. Illustrated description of new works at Franklin, Pa. 2000 w. Mach, N. Y—March, 1902. No. 46773.

Skimming Gates.

Some Skimming Gates. A. E. Fay. Illustrates some forms that have been used or suggested for the purpose of obtaining cleaner metal for the mold, with brief descriptions. 1500 w. Foundry—March, 1902. No. 46523.

Stern Frame.

Building a Stern Frame. Richard L. Tappenden. Illustrates and describes the building of an ordinary L-shaped frame. 800 w. Ir Age—March 27, 1902. No. 47121.

Tube Expander.

The Plastic Pressure Tube Expander. Illustrated description of a new device manufactured in England, and its operation. 1000 w. Am Mach—Feb. 27, 1902. No. 46511.

Watchmaking.

An Escape-Wheel Cutting Engine. A H. Cleaves. Illustrated description of a cutting machine and its operation. 1300 w. Am Mach—March 6, 1902. No. 46684.

Works Management.

See Industrial Economy.

MATERIALS OF CONSTRUCTION.

Budapest Congress.

New Researches in the Constitution of Materials (Ueber Neuere Arbeiten im Gebiete der Prüfung der Materialien der Technik). Prof. Fried. Kick. An illustrated review of some of the papers presented before the Budapest Congress of the International Association for the Testing of Materials, bearing particularly on solutions, metallography, etc. 4000 w. Zeitschr d Oesterr Ing u Arch Ver—March 7, 1902. No. 46945 B.

The Congress of the International Association for the Testing of Materials at Budapest in 1901 (Der Internationale Kongress für die Materialprüfungen der Technik zu Budapest, 1901). A general review of the congress and its proceedings. 2000 w. Schweiz Bauzeitung—Jan. 25, 1902 No. 46993 B.

Electrical Apparatus.

See Electrical Engineering. Miscellany.

Metallography.

Notes on Metallography (Note di Metallografia). A. Ruggieri. A discussion of the use of the microscope in metallographical investigation of materials used in naval construction. 5000 w. Rivista Marittima—Feb., 1902. No. 47188 G.

Oil.

The Way in Which the Qualities of Oil Are Determined. Dr. Julius Ohly. The determining the specific gravities, and conclusions drawn from observations. 1100 w. Mines & Min—March, 1902. No. 46777 C.

Recording Machine.

An Automatic Recording Machine. E. C. Oliver. Illustrates and describes a machine which records on a continuous strip of paper the momentary changes of conditions in making tests of steam, gas, or other engines or machines. 1800 w. Am Mach—Feb. 27, 1902. No. 46509.

Spherical Plates.

The Resistance of Spherical Plates to External Pressure (Die Widerstandsfähigkeit Kugelförmiger Wandungen gegenüber

We supply copies of these articles. See page 319.

Aeusserem Ueberdruck). C. Bach. A well illustrated experimental determination of the resistance of curved heads of boilers, etc., to pressures on the convex side. Serial. 1st part. 2000 w. Zeitschr d Ver Deutscher Ing—March 8, 1902. No. 46926 D.

POWER AND TRANSMISSION.

Aerial Tramways.

The Arlington Tramway. H. E. T. Haultain. An illustrated description of the tramway at Arlington mine, Erie, B. C. 1100 w. B. C. Min Rec—March, 1902. No. 46749 B.

Belting.

Belt Speeds and Journal Pressures. Letter from Forrest R. Jones on the common assumption that high speed belts result in increased pressure and friction at the journal bearings. 800 w. Eng Rec—March 15, 1902. No. 46885.

Horse-Power of Belting and Pulleys. E. C. DeWolfe. Diagram with explanation of its use. 2200 w. Power—March, 1902. No. 46688.

The Safe Management of Belts. An illustrated article giving hints based on a pamphlet issued by the "Association des Industriels de France contre les Accidents du Travail." 2500 w. Quarry—March 1, 1902. No. 46847 A.

Belt Shifters.

New Belt Shifters (Nouveaux Monte-Courroies Fixes pour Transmissions). Henry Mamy. A well illustrated description of apparatus for placing belts on pulleys in motion, without danger to workmen. 700 w. Génie Civil—Feb. 15, 1902. No. 46999 D.

Compressed Air.

Moisture in Compressed Air. D. W. Hering. Discusses the statements made concerning air compressed hydraulically, and explains the process. 2000 w. Compressed Air—March, 1902. No. 46815.

The Volumetric Efficiency of Air Compressors and Tests of Shütz Compressors at the "Centrum" and Fröhliche Morgensonne Mines, Westphalia (Ueber den Volumetrischen Wirkungsgrad der Kompressoren und Versuchsergebnisse von Shütz 'schen Kompressoren auf den Zechen "Centrum" und Fröhliche Morgensanne). R. Goetze. An illustrated description of experiments and results. 1500 w. Glückauf—Jan. 18, 1902. No. 46972 B.

Underground Compressed Air Mine Plant. Robert Peele. Considers the application of compressed air to rock drills, pumps, hoisting engines, and coal cutters. 5000 w. Mines & Min—March, 1902. No. 46779 C.

Elevators.

Elevator Safety Appliances. William Baxter, Jr. An illustrated review of the various appliances employed. 1600 w. Am Mach—March 13, 1902. Serial. 1st Part. No. 46887.

Mechanical Handling.

Mechanical Sorting of Small Packages at the Austerlitz Railway Station in Paris (Triage Mécanique des Petits Colis de Messageries (au depart) dans la Gare de Paris-Austerlitz). M. Pons. A well illustrated account of the mechanical handling, transporting of packages and parcels at this Paris station of the Orleans Railway. Serial. 2 parts. 4 plates. 12000 w. Rev Gén d Chemins de Fer—Feb., March, 1902. No. 47172 H.

Power Loss.

Power Loss by Friction and Transmission. Henry Souther. Read before the Canadian Mfr. Assn. Discusses this subject, giving Prof. Benjamin's rules to save friction losses in manufacturing establishments. 1600 w. Sta Engr—March, 1902. No. 47011.

Spiral Gears.

A Diagram for Laying Out Spiral Gears. J. N. Le Conte. Gives diagram and explanation of its use. 1200 w. Am Mach—Feb. 27, 1902. No. 46510.

Tractive Power.

Traction on Wagon Roads. Ira O. Baker. An account of experiments on the tractive power required to draw wagons on different roads and pavements, with general discussion of the subject. Ill. 2500 w. Eng News—March 8, 1902. No. 46696.

SPECIAL MOTORS.

Gas Engines.

Experimental Gas Engine Construction. Don McNaughton. On points of importance in the construction. 1800 w. Horseless Age—March 26, 1902. No. 47142.

Temperatures of the Cylinder Wall of a 400-Horse Power Double-Acting Gas-Engine. E Körting. Summarized translation from the *Zeitschrift des Vereines Deutscher Ingenieure*. An account of measurements of the temperature at different points, with a view to the prevention of injurious expansion. 1200 w. Jour Gas Lgt—March 11, 1902. No. 47067 A.

The Heat in Gas-Engine Cylinder-Walls. Illustrated review of some German experiments on a 400-h. p. two-cycle engine, to determine the temperature stresses in motors of this size. 1200 w. Eng Rec—March 15, 1902. No. 46883.

Gasoline Motors.

See Mechanical Engnr, Automobiles.

Mine Locomotives.

See Electric and Street Railways.

Orleans Tramway Plant.

See Electric and Street Railways.

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Boiler Erection.

Practical Points in the Erection of the Thornycroft Boiler. Description with diagrams. 1800 w. Marine Engng—March 1902. No. 47003 C.

Boiler Plant.

Hampton Boiler Plant. Illustrated description of a new boiler plant of the D. L. & W. Coal Mining Department at Scranton, Pa. 3000 w. Mines & Min—March, 1902. No. 46776 C.

Boilers.

Plans for Economical Boiler Feeding. W. H. Wakeman. Considers various plans for forcing water into boilers. 1600 w. Elec, N Y—March 12, 1902. No. 46750.

The Dürr Water-tube Boiler. S. J. Thompson. Abstract of a paper read before the So. Staffordshire Iron and Steel Inst. Illustrates and describes the construction of this land type of the Dürr boiler, its cleaning and the circulation. 1900 w. Ir & Coal Trds Rev—Feb. 21, 1902. No. 46502 A.

The Second Report of the Boiler Committee. A critical review of this report. 5500 w. Engr, Lond—March 7, 1902. No. 46860 A.

The Morrin Patent "Climax" Steam Boiler. Illustrated description of a water-tube boiler which has advantages of interest. Report of an extensive test, made by Bryan Donkin, is also given. 2500 w. Engng—March 14, 1902. No. 47082 A.

The Water Tube Boiler Question in the German Navy. Köhn von Jaski Translated from *Marine Rundschau.* A lengthy discussion of the reasons for the introduction of water-tube boilers, their disadvantages, choice of type, the fitting of German warships, economy of the various systems, efficiency, cost, etc. 15700 w. Jour Am. Soc of Nav Engrs—Feb., 1902. No. 47049 H.

Water-Tube Boilers. Report on trials of H. M. S. "Hyacinth," H. M. S. "Minerva," and R. M. S. "Saxonia," by the committee appointed by the Admiralty to inquire into the question of water-tube boilers for the British navy. 9500 w. Engng—Feb. 28, 1902. Serial. 1st part. No. 46726 A.

Cooling Towers.

Notes on the Construction and Operation of Cooling Towers. J. R. Bibbins. Description and tests of an experimental tower, for cooling circulating water in a steam power plant, recently put into service by the Edison Illuminating Co., of Detroit, with opinions on questions of design. 3000 w. Eng News—March 20, 1902. No. 47102.

Economy.

See Marine and Naval Engineering.

Engines.

The Engines of the New York Edison Power Station. Briefly describes this plant, located between 38th and 39th Sts, First Ave. and the East River, and particularly describes the remarkable features of the engines, giving illustrations. 900 w. Sci Am—March 22, 1902. No. 47114.

Fuel Economy.

Feed Water Heaters. D. B. Dixon. Considers it the most essential appliance in a steam power plant, discussing its advantages. 1400 w. Am Mfr—Feb. 27, 1902. No. 40537.

Heating Plant.

Central Steam Heating Plant on Randall's Island, New York City. Illustrated description of the system installed for 16 asylum buildings: the condensation water in buildings too low to return to the boiler house by gravity is handled by a vacuum system. 1000 w. Eng Rec—March 22, 1902. No. 47043.

Indicators.

Calculations From Indicator Diagrams. Charles L. Hubbard. Definition of work, foot pound, work diagrams, calculation of power, mean ordinate, planimeters, etc. 4000 w. Steam Engng—March, 1902. No. 47094.

Correcting for Variations in Indicator Springs. A. Koob. Gives methods for computing spring measurements. 2300 w. Power—March, 1902. No. 46689.

Reading Indicator Diagrams. Illustrates characteristics of the diagrams from various engines, explaining the meaning of the twists and turns. 2000 w. Steam Engng—March 1902. No. 47091.

Reducing Gears for the Steam Engine Indicator. W. H. Wakeman. An illustrated explanation of various devices for reducing crosshead motion to convenient proportions for use on the indicator drum, without destroying the peculiarities of the crosshead motion. 2400 w. Steam Engng—March, 1902. No. 47093.

Steam Engine Indicators. C. W. Obert. Illustrates and describes modern indicators, explaining the principle of Watt's, McNaught's, and Richards' instruments, and describing other forms. 2300 w. Steam Engng—March, 1902. No. 47090.

The Analysis of Indicator Diagrams. W. H. Wakeman. Gives diagrams and explains what they indicate. 1200 w. Engr, U S A—March 1, 1902. No. 46671.

The Preparation for Indicating. George L. Fowler. An illustrated article reviewing the work of preparation; the drilling and tapping the cylinders, piping, measuring clearance, attachment of indicator, etc. 2200 w. Steam Engng—March, 1902. No. 47092.

We supply copies of these articles. See page 319.

Watt's and McNaught's Steam Engine Indicators. Gives an account, in Watt's own words, of his first indicator, showing what he intended to effect by its means. Also notes improvements made by Watt and by McNaught. Ill. 2500 w. Engr, Lond—March 7, 1902. No. 46864 A.

Marine Engines.

See Marine and Naval Engineering.

Oil Fuel.

Oil Burning. H. B. Gregg. Discusses the essential equipment for the successful burning of crude oil in locomotives, giving tests. Ill. 3300 w. Wis Engr—Feb., 1902. No. 46530 D.

Radiators.

Tests of Radiators With Superheated Steam. R. C. Carpenter. Read at meeting of the Am. Soc. of Heat and Ven. Engrs. A report of tests which seem to indicate that superheated steam is a poor medium to employ for heating purposes. 1200 w. Dom Engng—March 15, 1902. No. 46889 C.

Sisson High Speed.

Sisson High Speed Compound Steam Engine (Machine à Vapeur Compound, à Grande Vitesse Système Sisson). A well illustrated description of a vertical engine, built by Wm. Sisson, of Gloucester, Eng., and exhibited at Glasgow, 1901. 1 plate. 800 w. Génie Civil—March 1, 1902. No. 47154 D.

Steam Engine Practice.

Modern Steam Engine Practice Abroad. Frank C. Perkins. Considers methods and general design in modern central stations in England, France, Belgium, Germany and Austria. Ill. 1700 w. Am Mfr—March 6, 1902. No. 46752.

Steam Laundry.

A Modern Steam Laundry. Illustrated description of a large laundry in Germany, and its mechanical appliances. 1000 w. Sci Am Sup—March 1, 1902. No. 46559.

Superheating.

Superheated Steam, from 1827 to the Present Day (La Vapeur Surchauffée, de 1827 à Nos Jours). G. Loffet. An illustrated general review of the subject, in theory and practice. Serial. 1st part. 2000 w. Rev Technique—Feb. 10, 1902. No. 47161 D.

Valve Gear.

History of the Walschaerts Valve Gear (Historie de la Distribution Walschaerts). Prof. J. Boulvin. A biographical sketch of Egide Walschaerts, of Belgium, and an illustrated history of his valve gear, which was mistakably attributed to Heusinger von Waldegg. 2000 w. Rev de Mecanique —Feb., 1902. No. 47168 E+F.

Valves.

Piston Valves. Illustrates and describes various types. 2200 w. Loc Engng—March, 1902. No. 46649 C.

Waste Heat.

Recent Experience and Tests with Waste Heat Engines. John H. Barr. An explanation of the operation of the binary vapor engines with a statement of certain properties of the working fluids employed. 1500 w. Sib Jour of Engng—March, 1902. No. 47058 C.

Water-Hammer.

On Explosions of Steam Pipes Due to Water-Hammer. C. E. Stromeyer. An illustrated explanation of how these explosions are brought about, with a mathematical discussion of the problem. 3800 w. Engng—Feb. 28, 1902. No. 46729 A.

MISCELLANY.

Aeronautics.

Aerial Navigation Problems. Carl E. Meyers. A reply to the article of Rear Admiral Melville published in the Dec. *North American Review*. 3500 w. Sci Am Sup—Feb. 22, 1902. No. 46503.

Maratime Aeronautics (L'Aéronautique Maritime). E. Surcouf. An illustrated, long, comprehensive review of aerial navigation above the sea, with recent progress and apparatus. 1 plate. 1800 w. Mem d l Soc d Ing Civils de France—Jan., 1902. No. 47171 G.

The Progress of Aeronautics (Les Progrès de l'Aéronautique). G. Espitallier. A well illustrated, comprehensive review with account of the recent experiments of Santos Dumont and other aeronauts. Serial. 3 parts. 13000 w. Génie Civil—March 1, 8 and 15, 1902. No. 47153 each D.

The Use of Balloons in War. Eric H. Stuart Bruce. Reviews the work that has been accomplished by military balloons, discussing goldbeaters' skin balloons and their advantages, and the use of balloons in the South African campaign. Also discussion. 6900 w. Jour Soc of Arts—Feb. 21, 1902. No. 48578 A.

The Villard Flying Machine. Illustrated description of the machine devised by M. Henri Villard. 900 w. Sci Am—March 8, 1902. No. 46695.

Alcohol.

Lighting and Heating with Alcohol at the Competition in Paris, 1901 (L'Eclairage et le Chauffage par l'Alcool au Concours de 1901). M. Lindet. A well illustrated comprehensive paper on lighting and heating with alcohol. 8000 w. Bull Soc d'Encouragement—Feb., 1902. No. 47157 G.

The Manufacture and Technical Uses of Alcohol in Germany. An account of a special exposition being held in Berlin,

We supply copies of these articles. See page 319.

with illustrated description of interesting exhibits of domestic and industrial uses of alcohol, including spirit engines and motors, flatirons heated, lamps, etc. 2200 w. U. S. Cons Repts, No. 1288—March 13, 1902. No. 46734 D.

Centrifugal Fans.

Application of the Principle of the Conservation of Energy to the Operation of Centrifugal Ventilators (Application du Principe de la Conservation de l'Energie au Fonctionnement des Ventilateurs Centrifuges). A. H. Courtois. A long, illustrated, mathematical discussion of the theory of centrifugal pumps and fans. The first part is devoted to pumps. Serial. 1st part. Tables. 16000 w. Rev de Mecanique—Jan., 1902. No. 47166 E+F.

Heating.

Central Heating Plants in the United States. Concerning the recent growth of commercial central heating stations. 1500 w. Eng News—March 20, 1902. No. 47105.

The Heating and Ventilation of the Edward Wyman School, St. Louis, Mo. Alvin D. Reed. Read before the Am. Soc. of Heat. & Ven. Engrs. Illustrated detailed description. 1400 w. Met Work—March 29, 1902. No. 47146.

Ventilation and Heating in the United States Mint, Philadelphia. Illustrated description of the apparatus for circulating the air through the building by means of both supply and exhaust fans. The warming is by direct steam radiation. 3000 w. Eng Rec—March 1, 1902. No. 46613.

Hot Water.

Hot Water Heating. P. Trowern. Read before the Canadian Assn. of Stationary Engrs. Briefly reviews the history of heating appliances, especially heating with hot water. 1400 w. Dom Engng—March 15, 1902. Serial. 1st part. No. 46890 C.

Mechanical Plant.

Mechanical Installation in the Modern Office Building. Continued discussion of paper on this subject by Charles G. Darrach. 9600 w. Pro Am Soc of Civ Engrs—Feb., 1902. No. 46534 E.

Machinery.

Weak Points in Machinery. Albert Stritmatter. Mentions certain evils that have thrown machines out of use, and discusses the remedy. Advises the manufacturer to keep track of as many machines as possible and endeavor to learn whether or not they are satisfactory, and if not, why not. 1200 w. Am Mfr—Feb. 27, 1902. No. 46539.

Metric System.

The English versus the Metric System. Charles T. Porter. An argument against the adoption of the metric system. 1000 w. Elec Rev, N Y—March 8, 1902. No. 46762.

Ordnance.

The Evolution of Fire-Arms and Ordnance and Their Relation to Advancing Civilization. General Joseph Wheeler. Historical review, with related matter of interest. 10600 w. Jour Fr Inst—March, 1902. No. 46795 D.

Pyrometer.

See Mining and Metallurgy, Miscellany.

Ventilation.

See also Mining and Metallurgy, Mining.

Weaving.

Recent Inventions in Weaving Machinery. Prof. Roberts Beaumont. Discusses many recent improvements made in looms. Also discussion. 8000 w. Jour Soc of Arts—Feb. 28, 1902. No. 6712 A.

MINING AND METALLURGY

COAL AND COKE.

Africa.

The Wankie Coalfield, Rhodesia. Description, with map, and report of progress and cost of working quality of coal, etc. 3000 w. Col Guard—Feb 21, 1902. No. 46594 A.

Ash Fusibility.

A Study of the Fusibility of the Ashes of Combustibles (Etude sur la Fusibilité des Cendres des Combustibles). MM. H. Le Chatelier and Chantepie. An illustrated account of experiments to determine the temperature of fusion of ashes of coal and other combustibles, with results. 2000 w. Bull Soc d'Encouragement—Feb., 1902. No. 47159 G.

Bituminous Coal.

Efficiency of Bituminous Coal. Harlan J. German. Discusses some of the losses which are incident to the combustion of bituminous fuels. 2200 w. Ry Mas Mach—March, 1902. No. 46637.

Bohemia.

The Coal Mining Industry of Northwestern Bohemia (Darstellung der Verhältnisse des Nordwestböhmischen Kohlenbergbaues). A general review of the Bohemian brown coal industry, as set forth in a speech by Frederick Zechner before the Austrian House of Deputies. 7000 w. Oesterr Zeitschr f Berg u Hüttenwesen—March 1, 1902. No. 46991 B.

British Columbia.

British Columbia Coal Fields. William

We supply copies of these articles. See page 319.

M. Brewer. Describes the various coal fields and collieries on Vancouver Island and the main land. 4800 w. Eng & Min Jour—March 22, 1902. No. 47099.

Calorific Value.

The Heating and Evaporative Power of Coal (Heizwert und Verdampfungsfähigkeit der Kohle). A. Dosch. From Dingler's Polytech Journal. This part gives the theoretical calorific power with different percentages of carbon, hydrogen, etc. Serial. Part I. Tables. 2000 w. Ill. Zeitschr f Klein u Strassenbahnen—March 1, 1902. No. 46910 C.

Coal Cutting.

Coal Cutting by Machinery in British Collieries. Sydney F. Walker. Illustrated description of machines used. 3000 w. Eng & Min Jour—March 8, 1902. Serial. 1st part. No. 46789.

Coal Supremacy.

See Industrial Economy.

Compressed Fuel.

Kuhn's Coal-Stamping Machinery. Illustrated description of a coal-compressing machine used in coking with explanation of its operation and statement of its advantages. 3800 w. Ir & Coal Trds Rev—Feb. 28, 1902. No. 46720 A.

The Charging of Coke Ovens with Compressed Fuel. Illustrates and describes appliances invented by John H. Darby for compressing fuel before coking, thus improving the quality and making it possible to obtain satisfactory results from some lean fuels. 1200 w. Col Guard—Feb. 28, 1902. No. 46724 A.

Faults.

A Lesson on Faults. Prof. Arthur Lakes. An illustrated sketch of the Aspen mining region, Colorado, in which the effects of faulting in the past, and still going on, are shown. 3000 w. Mines & Min—March, 1902. No. 46778 C.

Mid-Somerset.

The Mid-Somerset Coalfield Problem. Gives map and description of the peculiar geological formation found here, discussing the methods for extracting the coal. 3500 w. Col Guard—March 14 1902. No. 47124 A.

New Mexico.

The Coal, Graphite, and Oil Field of Raton, N. Mex. Prof. Arthur Lakes. Illustrates and describes the location and geological characteristics, the coal mines, and prospects for graphite and oil. 3000 w. Mines & Min—March, 1902. No. 46781 C.

Peat.

A New Process for Preparing Peat for Briquetting and Other Purposes (Ein Neues Verfahren zur Aufbereitung von Torf für Briquettirungs und Andere Zwecke). Gustav Kroupa. An illustrated description of methods and machines for pressing and briquetting peat. Serial. 2 parts. 1 plate. 4000 w. Oesterr Zeitschr f Berg u Hüttenwesen—Feb. 1, 8, 1902. No. 46984 each B.

New Method of Preparing Peat for Briquette Making, etc. G. Kroupa. From *Oesterreichische Zeitschrift für Berg und Huttenwesen.* Illustrated description. 900 w. Col Guard—March 7, 1902. No. 45866 A.

The Calorific Power of Peat (Ueber den Heizwerth des Torfs). Anderson and Dillner. An experimental investigation of peat in Sweden, abstracted from *Jernkontorets Annaler.* 2000 w. Oesterr Zeitschr f Berg u Hüttenwesen—Feb. 22, 1902. No. 46990 B.

COPPER.

Copper Supply.

Sources of Copper Supply. A discussion of the situation and the effects made to regulate the prices, and review of the sources of supply. 1400 w. Engr, Lond—Feb. 21, 1902. No. 46602 A.

Low-Grade Ores.

Electrolytic Recovery of Copper from Low-Grade Ores. N. S. Keith. States the conditions and considerations applied in the planning and erecting of works for the electrolytic method of recovering copper from the ores of a mine near New York city. The article is limited to the consideration of the variety of wet method in which electrolysis is used to effect the final deposition of the copper. 3400 w. Elec Rev, N Y—March 22, 1902. No. 47096.

Production.

American Copper Production. Editorial discussing the copper districts of the United States and the production for 1901, with some of the causes affecting it. 1700 w. Engng—March 7, 1902. No. 46859A.

Reduction Works.

Anaconda Copper Mining Company's New Reduction Works. An illustrated description of recently completed works, which are probably the largest, most complete and up-to-date of any of their kind. 4000 w. Eng & Min Jour—March 1, 1902. No. 46642.

Refining.

Electrolytic Refining of Copper. Illustrated description of the largest copper-refining works in the world, located at Raritan, N. J. 1700 w. Sci Am—March 15, 1902. No. 46811.

South America.

South American Copper. Editorial discussing the production in the various coun-

tries, especially Chili and Peru. 2000 w. Engng—Feb. 21, 1902. No. 46598 A.

Sweden.

The Nautanen Mineral Field (Das Erzfeld Nautanen). Björn Kjellberg. From *Teknisk Tidschrift*. An account of a copper region, in which gold occurs, near Gellivare, Sweden, with description of the ores. 700 w. Glückauf—March 1, 1902. No. 46982 B.

GOLD AND SILVER.

British Columbia.

Boundary District of British Columbia. E. Jacobs. Reports concerning the ore, shipments from various mines, their working, and other information. Ill. 3800 w. Eng & Min Jour—March 1, 1902. No. 46639.

Concentration.

Screen vs. Hydraulic Sizing. S. I. Hallett. On the use of vibrating screens and their advantage over hydraulic apparatus. 2000 w. Min & Sci Pr—March 1, 1902. No. 46679.

Dredging.

A Few Notes Upon Gold Dredging. F. Satchell Clarke. Gives some account of gold dredging in British Columbia, the types of dredges used, their operation, etc. 4000 w. Can Min Rev—Feb. 28, 1902. No. 46625 B.

Low Grade Ore.

A Method of Mining Low Grade Ores in the Boundary Creek District. Frederic Keffer. Describes the methods of mining at the Mother Lode mine in Deadwood Camp, and the reasons for their adoption. The ores contain copper, gold and silver in varying degree. Ill. 1600 w. Can Min Rev—Feb. 28, 1902. No. 46624 B.

Mexico.

The Guanajuato Mining District in Mexico. Henry Russell Wray. An illustrated article briefly reviewing the history, formation and general conditions of this district. 800 w. Min Rept—March 6, 1902. No. 46753.

Nome.

The Story of the Nome Gold Fields. Otto Halla. Reviews the history of this field since its discovery in July, 1898. 1900 w. Min & Sci Pr—March 1, 1902. No. 46680.

Ore Treatment.

Some Unsolved Questions of Ore Treatment. O. H. Howarth. Considers some of the mechanical and other imperfections in milling processes. 4400 w. Mines & Min—March, 1902. No. 46780 C.

Southern States.

Gold in North Carolina. Frederic Moore. Reviews the history of gold mining in this state, giving illustrations of the workings. 1200 w. Sci Am Sup—March 22, 1902. No. 47116.

Utah.

Stateline Mining District, Iron County, Utah. Grant H. Smith. Brief account of the mines. The ores carry gold and silver, associated with a small percentage of iron, and of manganese. 1400 w. Min & Sci Pr—Feb. 22, 1902. No. 46505.

Washington.

The Mount Baker Mining District, Washington. George Otis Smith. An illustrated description of this gold mining region. 1500 w. Eng & Min Jour—March 15, 1902. No. 46824.

IRON AND STEEL.

Basic Ingots.

The Non-Homogeneity of Soft Basic Open-Hearth Ingots (Ueber Inhomogenität der Weichen Basischen Martinblöcke) Adolf Riemer. An account of experiences with small ingots with analyses of different charges and different parts of the same ingot, and explanations of the non-homogeneity. 2200 w. Stahl u Eisen—March 1, 1902. No. 46968 D.

Blast Furnaces.

On Electric Lifts for Blast Furnace Bell-tops. F. Janssen. Illustrates and describes a blast-furnace bell-top lift which has been in operation about one year, stating the advantages from the employment of electricity. 2500 w. Ir & Coal Trds Rev—March 14, 1902. No. 47088 A.

The Operation of Blast Furnaces (Interessante Erscheinungen beim Hochofengauge und ihre Erklärung). Bernhard Osann. A paper before the Verein Deutscher Eisenhüttenleute discussing various interesting phenomena in blast furnace practice and their explanation. 6000 w. Stahl u Eisen—March 1, 1902. No. 46967 D.

Charging Machine.

Wellman Electric Charging Machine for Open Hearth Furnaces (Chargeuse Electrique, Système Wellmann pour Fours Siemens-Martin). An illustrated description of these machines for charging steel furnaces mechanically. 1500 w. Génie Civil—Feb. 15, 1902. No. 46996 D.

Constitution.

The Chemical Equilibrium of Ferro-Carbon Systems (Sur l'Equilibre Chiminique des Systèmes Fer Carbon). Georges Charpy et Louis Grenet. Discussion and experiments on the chemistry and constitution of combustions of iron and carbon. 500 w. Comptes Rendus—Jan. 13, 1902. No. 47176 D.

Crucible Steel.

The Improvements of the Crucible Steel

We supply copies of these articles. See page 319.

Company of America. Detailed description, with plans of new plants being built by this company. 2300 w. Ir Age—March 20, 1902. No. 47000.

Germany.

German Imports and Exports of Iron Ore, Iron, Iron Manufactures, Machines and Vehicles for 1900 and 1901 (Des Deutschen Zollgebietes Einfuhr begw. Ausfuhr von Eisenerz, Eisen, Eisenwaaren, Maschinen und Fahrzenengen in den Jahren 1901 und 1900). Complete statistical tables. 3 plates. Stahl u Eisen—March 1, 1902. No. 46971 D.

Lahn Valley.

The Probable Duration of Iron Mining in the Lahn and Dill Districts, Germany (Die Muthmassliche Dauer des Fortbestehens des Eisenerzbargbaud der Lahn und Dillreviere). An abstract of a memoir on the canalization of the Lahn, describing the iron geology and iron ores of these districts in Nassau, Germany. 1600 w. Stahl u Eisen—March 1, 1902. No. 46970 D.

Rheinish-Westphalia.

The Iron Industry in the Rhenish Westphalian Coal Region (Die Eisenhüttenindustrie im Rheinish-Westphälischen-Kohlenrevier). Abstract from the *Allgem. Deutscher Bergmannstag.* A historical and up-to-date review of iron and steel manufacture in this part of Germany. Serial. 2 parts. 4500 w. Oesterr Zeitschr f Berg u Hüttenwesen—Feb. 8, 15, 1902. No. 46987 B.

Rolling Mill.

A Two-High Roll Train with Electrically Driven Transfer Tables (Die Neue 950 er Duo Reversirstrasse mit Elektrisch Fahrbaren Rollgängen). An illustrated description of a rolling mill at Morgenroth, Silesia, in which the metal is handled between the passes by an electrically driven table which travels parallel to the rolls. 1 plate. 800 w. Stahl u Eisen—Feb. 15, 1902. No. 46964 D.

Hollow Geared Rolls with Internal Coupling (Ueber Hohlkammwalzen mit Innerem Augriff der Spindeln für Walzwerke). R. M. Daelen. An illustrated description of coupling shafts with spherical heads gearing into the hollow ends of rolls. 800 w. Stahl u Eisen—Feb. 15, 1902. No. 46963 D.

New Mill for Re-Rolling Worn Rails. Illustrated description of a new mill at Tremley Point, N. J., where the McKenna process of re-rolling old rails is to be installed. 2000 w. R R Gaz—March 14, 1902. No. 46827.

The Rolling of Sections in Iron and Steel. Adolph S. White. Considers the methods used in the rolling of angles and channels and their relative merits. Ill. 1800 w. Ir Age—March 27, 1902. No. 47122.

See also Mechanical Engineering, Miscellany.

Russia.

The Present State of the Russian Metallurgical Industry (Zur Gegenwätigen Lage der Russischen Montanindustrie). Dr. Neumark. A review of the Russian iron and steel and allied industries, with statistical tables. 3000 w. Stahl u Eisen—March 1, 1902. No. 46969 D.

United States.

Iron and Steel Works of the United States. James M. Swank. Extracts from the preface to the fifteenth edition of the *Directory to the Iron and Steel Works of the United States and Canada*, describing the condition at the close of 1901, as compared with 1898. 1700 w. Eng & Min Jour—March 8, 1902. No. 46788.

MINING.

Accidents.

Important Mining Accidents in 1901 (Bemerkenswerthe Unfälle beim Bergwerksbetriebe im Auslande). A brief record of mine accidents and explosions in all parts of the world. 800 w. Oesterr Zeitschr f Berg u Hüttenwesen—Feb. 15, 1902. No. 46989 B.

Electric Hoisting.

See Electrical Engineering, Power Applications.

Explosions.

Mine Explosions. Austin King. Gives the history and cause of those occurring in the bituminous regions of Pennsylvania since 1883, and the lessons taught by them. 4200 w. Mines & Min—March, 1902. No. 46782 C.

Notes on the Talk-o'-th'-Hill Explosion. An interesting account of the explosion which occurred May 27, 1901, killing four persons and twenty-seven horses and ponies. Also brief notes on other explosions. 2300 w. Col Guard—Feb. 21, 1902. No. 46593 A.

The Nature of Explosions. Review of Prof. Dixon's second lecture at the Midland Institute, Birmingham, Eng. The writer has been working in connection with this subject for twenty-five years. 3000 w. Quarry—March, 1902. No. 46848 A.

The Universal Colliery Explosion. Prof. W. Galloway. From the official Home Office Report. Describes the method of working, ventilation and general conditions, the explosion, supposed cause, means of preventing, etc. 5800 w. Ir & Coal Trds Rev—Feb. 28, 1902. No. 46721 A.

Hoisting Engines.

Notes on Mine Hoisting Engines. Rob-

ert Peele. Considers the hoisting engine from a mechanical engineering point of view, discussing the type form of ordinary intermittent-running engine. 8500 w. Sch of Mines Qr—Jan., 1902. No. 46797D.

Mine Pumps.

Mining Machinery (Les Machines de Mines). Henri Deschamps. An illustrated review of mining machinery at the Paris Exposition of 1900. The present part treats of pumping machinery. Serial. 1st part. 5 plates. 18000 w. Rev Univ d Mines—Jan., 1902. No. 46920 H.

Mining Locomotives.

Electric versus Compressed Air Mining Locomotives. Frank C. Perkins. The present article is mostly devoted to the compressed air locomotives and their advantages. Ill. 800 w. Min Rept—Feb. 7, 1902. Serial. 1st part. No. 46615.

Electric and Compressed Air Mining Locomotives. Frank C. Perkins. Considers the details of leading types, comparing their working advantages and disadvantages, etc. 1800 w. Min & Sci Pr—March 8, 1902. No. 46808.

See also Electric and Street Railways.

Mining Methods.

Mining Under an Old Gob. Explains the conditions and the methods used in extracting coal under difficulties. 1500 w. Col Guard—March 14, 1902. No. 47123 A.

Power in Mines.

The Distribution of Power in Mines. Sydney F. Walker. The first of a series of articles proposing to discuss the whole question of the distribution of power in and about mines, and also the distribution of air for ventilating purposes. 2000 w. Mines & Min—March, 1902. Serial. 1st part. No. 46783 C.

Rock Drill.

The Flottmannsche Rock Drill (Die Flottmannsche Gesteinsbohrmaschine). Hr. Limberg. An illustrated description of a rock drill to be driven by compressed air or steam, with improved valve gear having very little friction. 1 plate. 1500 w. Glückauf—March 8, 1902. No. 46983 B.

Rope Haulage.

The Rope Haulage Plant at Diedenhofen, Lorraine (Die Seilförderungsanlage im Karlstolln bei Diedenhofen). Hr. Heise. An illustrated description of a rope-haulage plant for an iron mine tunnel. 1 plate. 2500 w. Glückauf—Feb. 1, 1902. No. 46977 D.

Shaft Sinking.

Shaft Sinking at the Dubensko Coal Mine in Upper Silesia (Das Schlachtabteufen des Junghannschachtes II auf der Dubenskogrube in Oberschlesien). E. Langer. Abstract of a paper before the International Meeting of Boring Engineers at Karlsbad, giving an account of shaft sinking through watery quicksand. Ill. 900 w. Glückauf—March 1, 1902. No. 46981.B.

Stratameter.

The Gothan "Stratameter" (Der Stratameter von Hermann Gothan in Gross-Lichterfelde). H. Thumann. Paper before the International Meeting of Boring Engineers at Karlsbad, in 1901, describing a compass needle apparatus for determining the dip and strike of strata encountered in bore holes, and the plumbness of the latter. 1600 w. Glückauf—Jan. 18, 1902. No. 46973 B.

Ventilation.

Losses of Pressure in the Ventilation of Mine Workings (Ueber Druckverluste bei der Bewetterung der Abbaubetriebe). Franz Pospisil. General discussion of various methods of working, with observations at a coal mine in Moravia. 1 plate. 2400 w. Oesterr Zeitschr f Berg u Hüttenwesen—Feb. 1, 1902. No. 46985 B.

Winding.

Winding from Great Depths. An illustrated detailed description of the Whiting system is given in the present article. 2000 w. Ir & Coal Trds Rev—Feb. 28, 1902. Serial. 1st part. No. 46722 A.

MISCELLANY.

Alloys.

Upon the Constitution of Binary Alloys. John Alexander Mathews. Continued discussion. 3000 w. Jour Fr Inst—March, 1902. No. 46796 D.

Aluminum Alloys.

Alloys of Aluminum with Iron and with Manganese (Contribution à l'Etude des Alliages Aluminium-Fer at Aluminium-Manganèse). Leon Guillet. A record of chemical experiments. 600 w. Comptes Rendus—Jan. 27, 1902. No. 47193 D.

Austria.

The Austrian Mineral Industry for 1900 (Die Bergwerksproduktion Oesterreichs im Jahre 1900). Statistical tables of the production of metals and minerals. 800 w. Glückauf—Jan. 18, 1902. No. 46974 B.

Manganese.

The Occurrence of Manganese Associated with Iron at Platten in Bohemia and Johanngeorgenstadt in Saxony (Das Vorkommen von Manganerzen in Gesellschaft von Eisenerzen bei Platten in Böhmen und Johanngeorgenstadt in Sachsen). Josef Lowag. Geological and mineralogical description, with some production figures. Serial. 2 parts. 4000 w. Oesterr Zeitschr f Berg u Hüttenwesen—Feb. 8, 15, 1902. No. 46986 B.

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RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Accidents.

Should Executive Officers Be Held Criminally Responsible for Accidents? Editorial discussion of Park Avenue tunnel disaster and the indictment of the Grand Jury. 2000 w. Eng News—March 13, 1902. No. 46804.

Capacity.

Limit of Capacity of Single Track. Presents papers by H. C. Thompson and Augustus Mordecai, read in 1883, also responses to a general invitation to discuss this subject, and an editorial. 18700 w. Ry & Engng Rev—March 15, 1902. No. 47030.

Employes.

Vision, Color-Sense and Hearing. Charles H. Williams. Considers methods of examination and required standards. Also discussion. 18000 w. W Ry Club—Feb. 18, 1902. No. 46792 C.

Locomotive Running.

Successful Locomotive Engine Running. Paper by R. S. Goble, read before the Pacific Coast Ry. Club. On the necessity of practical experience. 2000 w. Ry Mas Mech—March, 1902. No. 46638.

Trains Parting.

Control of Trains Parted Between Air-Brake Cars. E. W. Pratt. Believes all cars should be equipped with automatic brakes and enginemen carefully instructed in handling long trains. 1300 w. R R Gaz—March 21, 1902. No. 47109.

MOTIVE POWER AND EQUIPMENT.

Balancing.

The Balancing of Locomotive Engines. Information from leading locomotive superintendents and engine builders of Great Britain as to what is the best practice of to-day. 4600 w. Engr, Lond—Feb. 28, 1902. No. 46731 A.

Brakes.

The Combined Straight Air and Automatic Engine and Tender Brake. F. B. Farmer. From a paper read before the Northwest Ry. Club. States the disadvantages of the automatic brake in switching, and the advantages of the straight air brake, and the reasons why the new arrangement is considered desirable. Ill. 3200 w. Ry Age—March 14, 1902. No. 46895.

Brake Shoes.

Locomotive Brake Shoes. W. H. Stocks. A report of a comparative brake shoe test recently made on the C. R. I. & P. Ry. with discussion. 9300 w. W Ry Club—Feb. 18, 1902. No. 46793 C.

Cars.

Best Methods in Shop Practice in Meeting the Requirements for the Maintenance of All-Steel Cars. Paper by W. S. Morris, with lengthy discussion. Ill. 15600 w. N Y R R Club—Feb. 20, 1902. No. 46873.

80,000-Lb. Capacity Box Car. Illustrated description of a new standard 36-ft. box car for the N. Y. C. & H. R. R. 500 w. Am Engr & R R Jour—March, 1902. No. 46540 C.

Santa Fe Combination Steel and Wood Box Car, 80,000 Pounds' Capacity. Illustrates and describes a car having special features which are novel, and designed with a view to overcoming defects. 1200 w. Ry Age—Feb. 28, 1902. No. 46631.

The New York Central Box Car. Illustrations of the standard box car F 8 are presented, showing how the problem of designing an all-wood box car has been solved. 900 w. Ry Age—Feb. 28, 1902. No. 46630.

Electrical Driving.

The Electric Problem of Railways. James Swinburne. Read before the Manchester Sec. of the Inst. of Elec. Engrs. Considers the different systems in use and of possible application. 6500 w. Mech Engr, Lond—March 1 and 8, 1902. 2 parts. No. 46875 each A.

High Speed.

High Speed and Electric Operation on Standard Railways (Ueber Schuellbahnen und Elektrische Zugförderung auf Hauptbahnen). Hr. Wittfeld. A discussion before the Verein für Eisenbahnkunde, of the comparative merits of steam and electric traction. 7000 w. Glasers Ann—March 1, 1902. No. 46931 D.

See also Electric and Street Railways.

India.

The Design and Construction of Railway Carriages in India. C. F. Bamford. Illustrates and describes the design and construction of the different railway passenger carriages adopted on the Assam-Bengal Railway metre-gauge, and also the general practice adopted by other Indian broad and metre-gauge railways. 1800 w. Engng—Feb. 21, 1902. Serial. 1st part. No. 46595 A.

Journals.

Notes on the Wear of Journals. David Van Alstine. Notes on an investigation made of the consumption of axles, by C. G. W. Ry. 2300 w. R R Gaz—Feb. 21, 1902. No. 46498.

We supply copies of these articles. See page 319.

Locomotives.

Compound Express Locomotive of the Adriatic Railway, Italy (Locomotive Compound Express des Chemins de Fer de l'Adriatique). F. Barbier. A well illustrated description of an Italian locomotive with the cab in front and smokestack in rear, three pairs of drivers and four-wheeled bogie truck, exhibited at Paris. 1 plate. 2500 w. Génie Civil—March 8, 1902. No. 47155 D.

Compound Ten-Wheel Passenger Locomotive. Illustrated detailed description of this new locomotive for the Plant System, which is the 20,000th locomotive built by the Baldwin Locomotive Works, and a most interesting engine. It combines the four-cylinder balanced construction with the Vanderbilt boiler and tender. 900 w. Am Engr & R R Jour—March, 1902. No. 46541 C.

Express Engines, Furness Railway. Sectional drawings, with dimensions and description of some powerful express bogie passenger engines. 600 w. Engr, Lond—Feb. 21, 1902. No. 46603 A.

Rogers Cross Compound for the Great Northern. Detailed description with illustration. 800 w. Loc Engng—March, 1902. No. 46645 C.

The Differentiation of the American Locomotive. J. C. Bayles. A comparison of engines built 70 years ago with those of to-day, the types being represented by "Old Ironsides," built in 1832, and the Ten-wheel locomotive recently built for the Plant System. 2200 w. Ir Age—March 6, 1902. No. 46607.

The Locomotive. Ira C. Hubbell. Extracts from a paper read before the Ry. Club of Pittsburg, discussing the question of cylinder-clearance and economy of steam distribution in general. 1200 w. Ry & Engng Rev—March 1, 1902. No. 46644.

The Tractive Power of Locomotives. Edward C. Schmidt. Gives tables and curves showing the results of two methods of determining the draw-bar pull of four locomotives. 600 w. R R Gaz—March 7, 1902. No. 46790.

Springs.

Underhung Springs. J. P. Kelley. On the method of hanging the driving springs and the equalizers of locomotives, and related subjects. Ill. 1300 w. Loc Engng—March, 1902. No. 46648 C.

Train Acceleration.

A Consideration of the Inertia of the Rotating Parts of a Train. Norman Wilson Storer. An investigation of this feature which has been almost neglected. 1500 w. Trans Am Inst of Elec Engrs—Feb., 1902. No. 46656 D.

The Relation of Energy and Motor Capacity to Schedule Speed in the Moving of Trains by Electricity. Cary T. Hutchinson. A general solution of the question involved in the movement of a body from rest to rest, covering all cases that can arise in ordinary practice of train movement. 5700 w. Trans Am Inst of Elec Engrs—Feb., 1902. No. 46655 D.

The Selection of Electric Motors for Railway Service. W. B. Potter. Discussing the paper of Dr. Cary T. Hutchinson, pointing out some variations from the average met with in the practical consideration of motor selection. 2500 w. Trans Am Inst of Elec Engrs—Feb., 1902. No. 46657 D.

PERMANENT WAY AND BUILDINGS.

Buildings.

Buildings. Report of the American Railway Engineering and Maintenance of Way Association, on coaling stations and water tanks. Ill. 11700 w. Ry Age Special No. March 21, 1902. No. 47136 D.

Bumping Posts.

Hydraulic Bumping Posts (Hydraulische Prellböcke). An illustrated description, partly from a paper by Hr. Sarre before the Verein für Eisenbahnkunde, of bumping posts with hydraulic cylinders, in use in German railway stations. 1000 w. Zeitschr f Lokomotivführer—Feb. 28, 1902. No. 46914 B.

Coaling.

Locomotive Coaling Stations. Waldon Fawcett. Illustrates and describes a recent system of coaling which the writer considers almost perfect. A steel coal pocket of the suspended-bin type is mounted above the tracks. The arrangements for filling are described and also for emptying the ashes. 1500 w. Loc Engng—March, 1902. No. 46647 C.

Coaling Stations.

The New Chicago & Alton Coaling Stations. Illustrated descriptions of these stations and their equipment. Arrangements are such that locomotives receive their supply of coal, water, and sand, and discharge the cinders from fire-box and smoke-box simultaneously. 1000 w. R R Gaz—March 14, 1902. No. 46837.

Construction Work.

New Construction Work on the Pennsylvania R. R. Extracts from the annual report giving interesting particulars of recently completed work. 1500 w. Eng News—March 13, 1902. No. 46802.

Crossings.

Time Lock to Prevent Derailments at Interlocked Grade Crossings. Illustrated description of a mechanical time lock. 1000 w. Eng News—March 13, 1902. No. 46803.

We supply copies of these articles. See page 319.

Freight House.

New Freight House for the Chicago Great Western, in Chicago. Illustrated description of a new four-story house equipped with modern conveniences for handling the freight of a large city terminal. 700 w. Ry & Engng Rev—March 15, 1902. No. 47029.

Freight Yards.

Freight Yards of the Chicago Transfer and Clearing Co. Illustrated detailed description of work nearly completed, which will give an immense switching yard connected with all railroads entering Chicago. 2100 w. R R Gaz—March 14, 1902. No. 46833.

The New Pennsylvania Yard at Pittsburg. Two-page plate with description of an entirely reconstructed and greatly enlarged yard and approaches. 1400 w. R R Gaz—March 14, 1902. No. 46835.

Improvements.

Bridge and Track Improvements on the Chicago & Alton. Deals with roadway improvements during the past year, giving photographs of the interesting structures. 2200 w. Ry Age, Special No—March 21, 1902. No. 47131 D.

The Improvements in the Pennsylvania Division of the New York Central & Hudson River Railroad. Two-page plate with description. 1400 w. R R Gaz—March 14, 1902. No. 46830.

Work of the Past Year in and Around Chicago. An account of the extensive track elevation, including elevation of yards, and involving many difficulties; the building of freight-houses and suburban passenger stations; interlocking plants; enlarged yards and terminals &c. 2800 w. R R Gaz—March 14, 1902. No. 46826.

Yard and Stations Improvements at St. Paul, Minn. General plan of rearrangement of track system for the St. Paul Union Depot Co. with illustrated description of other improvements. 2000 w. Ry Age, Special No—March 21, 1902. No. 47129 D.

Interlocking.

New Interlocking Plant at the Pittsburg Terminal of the P. R. R. Illustrates the general layout of the tracks and the arrangement of the switch machines and signals. 400 w. Ry & Engng Rev—March 15, 1902. No. 47032.

Proposed Interlocking for a Gauntlet Track Arrangement. W. M. Torrence. Shows an arrangement designed by the writer for use in connection with work of lining the east end of Musconetcong tunnel on the Lehigh Valley R. R. 800 w. Ry & Engng Rev—March 15, 1902. No. 47027.

Masonry.

Masonry. Report of the American Railway Engineering and Maintenance of Way Association, with discussion. 25600 w. Ry Age, Special No—March 21, 1902. No. 47140 D.

New York Central.

New York Central's Current Engineering. Illustrations and description of features which may be considered as samples of the standard engineering of the road in the lines covered. 5800 w. Ry Age, Special No—March 21, 1902. No. 47130 D.

Rail.

Rail. Report of American Railway Engineering and Maintenance of Way Association, with discussion. 10000 w. Ry Age, Special No—March 21, 1902. No. 47137 D.

Railway Curves.

Line and Surface for Railway Curves. Charles C. Wentworth. Discusses the original center line used as the base of measurement, indicating what was wrong, and proposing simpler means for correcting the trouble than those now in use. 2000 w. Pro Am Soc of Civ Engrs—Feb., 1902. No. 46532 E.

Roadway.

Roadway. Report of the American Railway Engineering and Maintenance of Way Association, with discussion at the Chicago convention. 16700 w. Ry Age, Special No—March 21, 1902. No. 47133 D.

Sheds.

Railway Platform Sheds (Freistehende Perronhallen). Karl Haberkalt. An illustrated mathematical discussion of the design and construction of roofs and their supporting columns for station platforms. 1 plate. 6000 w. Oesterr Wochenschr f d Oeffent Baudienst—March 8, 1902. No. 46937 B.

Shops.

New Shops at the Ft. Worth & Denver City Ry. Illustrated detailed description of small shops with provision for extension. 800 w. R R Gaz—March 21, 1902. No. 47110.

The New Shops of the Union Switch and Signal Company. Illustrated detailed description of new shops at Swissvale, Pa. 1100 w. R R Gaz—March 14, 1902. No. 46836.

Herman's Automatic Electric Semaphore. Illustrated description of an instrument designed to work three-position signals. 1200 w. R R Gaz—March 14, 1902. No. 46831.

Rowell-Potter Safety Stop and Block Signals on the C. M. & St. P. Ry. Describes the apparatus in detail giving illustrations, and discusses the subject of signalling generally. 3800 w. Ry & Engng Rev—March 15, 1902. No. 47031.

We supply copies of these articles. See page 319.

The Miller Locomotive Cab Signal. Illustrates and describes the essential features of this system, by which stop and go-ahead signals are given in the cab of the locomotive. 2200 w. R R Gaz—Feb. 21, 1902. No. 46499.

Structures.

Iron and Steel Structures. Report of the American Railway Engineering and Maintenance of Way Association, on contracts for bridge work, specifications for rolled steel, live loads, impact and unit strains, with discussion. 16800 w. Ry Age, Special No—March 21, 1902. No. 47138 D.

Terminals.

A Model Terminal Station. Illustrates and describes the mechanical and electrical equipment of the new terminal station of the Pittsburg & Lake Erie, at Pittsburg, Pa. 6000 w. Ry Age, Special No.—March 21, 1902. No. 47127 D.

Inadequate Freight Terminals. George Hannauer, with discussion. Discusses local conditions at St. Louis, which are similar to other large cities, and the remedy. Shows what a freight terminal should be, &c. 7000 w. St. Louis Ry Club—Feb. 14, 1902. No. 46627.

New Chicago Terminal for Lake Shore & Michigan Southern and Chicago, Rock Island & Pacific. Illustration, plans, and descriptive notes. 600 w. R R Gaz—March 14, 1902. No. 46834.

Terminal Improvements of the Plant System, at Port Tampa, Fla. A comprehensive illustrated description of this terminal, including much recent engineering work and giving much information of the business which passes through this point. 3300 w. Ry & Engng Rev—March 15, 1902. No. 47021.

Ties.

Buhrer Steel Ties on the Lake Shore & Michigan Southern Ry. A statement of the efficiency, serviceability and cost of these ties. 1500 w. Ry & Engng Rev—March 15, 1902. No. 47024.

Ties. Report of the American Railway Engineering and Maintenance of Way Association, with discussion at the Chicago convention. 17200 w. Ry Age, Special No—March 21, 1902. No. 47135 D.

Track.

Track. Report of the American Railway Engineering and Maintenance of Way Association, with discussion at the Chicago convention. 16400 w. Ry Age, Special No—March 21, 1902. No. 47134 D.

Tunnel Ventilation.

The Ventilation of the Simplon Tunnel (Die Ventilationsanlagen am Simplontunnel). C. I. Wagner. An illustrated account of the ventilating plant and method of ventilation. 2 plates. 2500 w. Oesterr Wochenschr f d Oeffent Baudienst—Feb. 15, 1902. No. 46933 B.

Union Station.

The Proposed Union Station for Washington, D. C. Map, showing erection of a proposed station for the Pennsylvania and Baltimore & Ohio railroads, with information concerning it. 1100 w. Ry Age, Special No—March 21, 1902. No. 47128 D.

Yards.

On Yards and Terminals. Report of the American Railway Engineering and Maintenance of Way Association, giving plans and discussion. 14000 w. Ry Age, Special No—March 21, 1902. No. 47139 D.

MISCELLANY.

Austria.

Statistics of the Austrian Local Railways for 1899 (Uebersichts-Tabellen, zusammengestellt aus der Statistik des Verbandes der Oesterreichischen Localbahnen für das Jahr 1899). General statistical tables. 3000 w. Mitt d Ver f d Förderung d Local u Strassenbahnwesens—Feb., 1902. No. 46923 D.

Bosnia-Herzegovina.

The State Railways of Bosnia and Herzegovina (Die Bossnisch-Herzegowinischen Staatsbahnen). From the *Zeitschr, d. Vereins Deutscher Eisen-Verwaltungen.* A general statistical report of these railways and their operation in 1900. 1600 w. Ill Zeitschr f Klein u Strassenbahnen—Jan. 16, 1902. No. 46904 C.

Cuba.

Cuban Railroads. From *The Economist.* A review of existing railroads, their financial standing, &c. 1000 w. R R Gaz—Feb. 28, 1902. No. 46576.

Organization.

Railroad Organization. George T. Sampson. General remarks with a description of one of the best organizations in the United States, and as the writer believes, in the world. 13000 w. Jour Assn of Engng Socs—Jan., 1902. No. 46706 C.

Prussia.

Budget for the Prussian State Railways in 1902 (Etat der Eisenbahn-Verwaltung für das Etatsjahr 1902). The official estimates for operation and maintenance, with many tables. Serial. 6000 w. Glasers Ann —Feb. 15, 1902. No. 46930 each D.

Switzerland.

Statistics of the Swiss Railways for 1899 (Statistique des Chemins de Fer Swisses pour l'Année 1899). An analysis of the Government statistics. Tables. 2000 w. Rev Gen d Chemins de Fer—March, 1902. No. 47175 H.

We supply copies of these articles. See page 319.

STREET AND ELECTRIC RAILWAYS

Accumulator Locomotive.

Switching Locomotive with Electric Accumulators (Elektrische Rangier-Lokomotiven mit Akkumulatoren). An illustrated description of a 40-H. P. electric locomotive carrying a storage battery of 120 cells. 1000 w. Ill Zeitschr f Klein u Strassenbahnen—Feb. 16, 1902. No. 46908 C.

Alternating Currents.

Four-Motor Equipments and the Possibilities of Alternating Currents for Street Railway Service. Albert H. Armstrong. Extract from an address before the New England Street Ry. Club, on the suburban phase of street railway work. 2800 w. St Ry Jour—March 8, 1902. No. 46747 D.

Berlin.

Interesting Constructions on the Berlin Electric Elevated and Underground Railway (Intercessante Montagen der Elektrischen Hoch- und Untergrundbahn zu Berlin). Hans Dominik. A well illustrated account of various interesting features of the construction work. Two parts. 3000 w. Ill Zeitschr f Klein-u Strassenbahnen—Jan. 1, 16, 1902. No. 46902 each C.

The Berlin Electric Elevated and Underground Railway (Die Elektrische Hoch- und Untergrundbahn in Berlin). Hr. Langbein. A very well illustrated and complete account of all the features of this road, which has lately been opened for traffic. Serial. 3 parts. Map. 24000 w. Zeitschr d Ver Deutscher Ing—Feb. 15, 22, March 1, 1902. No. 46925 each D.

The Berlin Elevated and Underground Electric Railway. Abstract translation of an article by Mr. Gisbert Kapp, which appeared in the *Elektrotechnische Zeitschrift*, giving a description of the undertaking. Ill. 2200 w. Elec Engr, Lond—March 7 & 14, 1902. Serial. 2 parts. No. 46852 each A.

The Berlin Electric Elevated and Underground Railway (Die Elektrische Hoch- und Untergrundbahn in Berlin). Gisbert Kapp. A well illustrated description of the road, the cars and the power station. 3500 w. Elektrotech Zeitschr—Feb. 13, 1902. No. 46333 B.

The Stations of the Berlin Electric Elevated and Underground Railway (Die Bahnöfe der Elektrischen Hoch- und Untergrundbahn zu Berlin). Hans Dominik. A well illustrated description of the stations on the new Berlin electric railway. Two parts. 2500 w. Ill Zeitschr f Klein u Strassenbahnen—Feb. 16, Mar. 1, 1902. No. 46907 each C.

British Isles.

Recent Electric Tramway Practice in the British Isles. P. T. J. Estler. Abstract of a paper read before the University College Engng. Soc., London. The paper is confined to the overhead trolley system and discusses the permanent way, overhead equipment, generating station and rolling-stock. Ill. 7500 w. Tram & Ry Wld—Feb. 13, 1902. No. 46591 B.

Chamonix.

Electric Railway from Fayet to Chamonix and the Swiss Frontier (Chemin de Fer Electrique du Fayet à Chamonix et à la Frontière Suisse). M. Geoffray. A well illustrated description of this third-rail road near Mont Blanc and its hydro-electric plants. 3 plates. 16000 w. Ann d Ponts et Chaussées—3 Trimestre, 1901. No. 46918 E+F.

Conduit System.

The Cost of the London Tramway Conduit System. A report of the proposed conversion of the tramway lines to this system of electric traction, the present position of the undertaking, cost, &c. 1700 w. Engr, Lond—Feb. 21, 1902. No. 46600 A.

Convertible Car.

The Duplex Car for Summer and Winter Use (Der Duplexwagen, ein neuer Sommer- und Winter-Wagen). Hans Dominik. An illustrated description of a new convertible electric car. 700 w. Ill Zeitschr f Klein u Strassenbahnen—March 1, 1902. No. 46909 C.

Electric Locomotive.

Three-Phase 10,000-Volt Railway at Gross-Lichterfelde. Frank C. Perkins. Illustration, with description of a Siemens & Halske three-phase current locomotive, and brief account of the experimental line on which it is used. 8000 w. Sci Am—March 22, 1902. No. 47115.

Electric Tramways.

Recent Electric Tramway Practice. P. T. J. Estler. Abstract of a paper read before the London Univ. Col. Engng. Soc. Deals only with the overhead trolley system, discussing the permanent way in the present article. 3000 w. Mech Engr, Lond—March 15, 1902. Serial. 1st part. No. 47064 A.

English Tramways.

Electric Traction on English Railroads and Tramways. On the present position of electric traction matters in Great Britain. 1800 w. R R Gaz—Feb. 28, 1902. No. 46573.

Equipment.

The Electrical Equipment of the Providence, Warren & Bristol Railroad. De-

We supply copies of these articles. See page 319.

scribes the equipment of this section of the New York, New Haven & Hartford Railroad, with the overhead trolley system. Ill. 2400 w. St Ry Jour—March 1, 1902. No. 46766 D.

High Speed.

High Speed Railways (Ueber Eisenbahn-Schnellverkehr). Ludwig Ritter v. Stackert. An illustrated paper giving a general discussion of high-speed railways, including steam, electric, suspended, etc. 7000 w. Zeitschr d Oesterr Ing u Arch Ver—Feb. 14, 1902. No. 46940 B.

Operating Notes on High Speed Electric Railways. States the conditions at present existing on interurban electric roads, discussing recent improvements, and needed improvements. 2500 w. St Ry Rev—March 15, 1902. No. 47017 C.

The Berlin-Zossen High-Speed Electric Railway Experiments. Enrico Bignami. Notes recent progress in Europe in regard to electric traction and begins an illustrated description of this experimental line and its working. 3000 w. Elec Rev, N. Y —March 8, 1902. Serial. 1st part. No. 46761.

Hungary.

Statistics of Hungarian Electric Street Railways for 1900 (Betriebsergebnisse der Elektrischen Strassenbahnen in Ungarn tür das Jahr 1900). General statistical table. 300 w. Mitt d Ver f d Förderung d Local u Strassenbahnwesens—Feb., 1902. No. 46924 D.

Interurban.

The Grand Rapids, Holland and Lake Michigan Rapid Ry. William D. Ray. From a paper read before the Chicago Elec. Assn. Illustrated detailed description of the line and its equipment. 9000 w. St Ry Rev—March 15, 1902. No. 47015 C.

Italy.

Electrical Operation on the Italian Mediterranean Railway (Elektrischer Betrieb auf den Linen der "Italienischen Mittelmeer-Eisenbahn-Gesellschaft"). A comprehensive illustrated description of standard electric railways running north from Milan and their power station and substations. 2000 w. Mitt d Ver f d Förderung d Local u Strassenbahnwesens—Jan., 1902. No. 46912 D.

Electric Traction on the Railway Lines from Milan to other Northern Towns of Italy (Traction Electrique sur les Lignes de Milan à Gallarate, Varese, Porto Ceresio, Arona et Laveno). Illustrated description of these electric railways of the Italian Mediterranean Company and of the power plants. 1 plate. 4000 w. Rev Gen d Chemins de Fer—Feb., 1902. No. 47174 H.

Journals.

Test of a Ball Bearing Car Journal on the Fitchburg Electric Ry. Illustrates and describes the Chapman double ball bearing, and gives report of comparative test between this and a car fitted with the ordinary journal bearing. 1500 w. Ry & Engng Rev—Feb. 22, 1902. No. 46478.

London.

The Great Northern and City Railway. Illustrated description of this underground road, the tunnel and the special shield designed for the work, and its method of operation. Ill. 5400 w. St Ry Jour—March 1, 1902. No. 46770 D.

The Central London Underground Electric Railway (Die Central London Untergrundbahn mit Elektrischen Betriebe). E. A. Ziffer. A well illustrated paper, giving a comprehensive account of this railway and its operation. 5000 w. Mitt d Ver f d Förderung d Local u Strassenbahnwesens—Jan., 1902. No. 46911 D.

Mine Locomotives.

The Progress of Locomotive Haulage in Mines (Die Fortschritte der Lokomotivförderung). Hr. Baum. A comprehensive illustrated review of locomotives for mine haulage, principally electric and benzine. Serial. 3 parts. 7 plates. 17000 w. Glückauf—Jan. 25, Feb. 8, 15, 1902. No. 46975 each B.

Moving Sidewalk.

A Subterranean Electric Moving Platform for Paris (Nouvelles Applications des Plates-Formes Roulantes Souterraines à Traction Electrique). D. A. Casalonga. An illustrated description of a proposed moving platform under the boulevards of Paris from the Place de la Concorde to the Place de la Bastille. 2000 w. Mem d l Soc d Ing Civils de France—Jan., 1902. No. 47170 G.

Operating Costs.

Operating Costs and Guaranties of Electric Street Railways (Betriebskosten und Betriebskostengarantie bei Elektrischen Strassenbahnen). An analysis of costs so as to enable guaranties of operating costs to be made intelligently. 3000 w. Ill Zeitschr f Klein u Strassenbahnen—Feb. 16, 1902. No. 46906 C.

Orleans.

The Orleans, France, Electric Tramway and its Gas Power Plant (Die Elektrische Tramway in Orleans und deren Kraftgas-Anlage). E. A. Ziffer. An illustrated description of this road and particularly of gas producing plant and gas engines, with a general discussion of the use of power gas. 1 plate. 5000 w. Mitt d Ver f d Förderung d Local u Strassenbahnwesens—Feb., 1902. No. 46922 D.

We supply copies of these articles. See page 319.

Railway Motors.

Geared Electric Motors for City and Suburban Railways (Zahnradmotoren für Stadt- und Vorotbahnen). Hr. Siebert. An illustrated discussion of motors for railway work. 1000 w. Elektrotech Zeitschr—March 6, 1902. No. 46954 B.

Roadbed.

Concrete Roadbed Construction for Street Railways. Discusses the best practice for city streets, and gives the details of roadbed construction for street railways in a number of large cities where concrete is used to a greater or less extent. Ill. 3500 w. Eng News—March 6, 1902. No. 46698.

Safety Frame.

Safety Apparatus for Electric Street Cars (Schutzvorrichtung gegen das Ueberfahren durch Elektrische Strassenbahnwagen). Max. v. Leber. An illustrated description of a movable frame which is automatically dropped in front of the wheels and prevents people from being run over. 600 w. Zeitschr d Oesterr Ing u Arch Ver—March 7, 1902. No. 46947 B.

Signals.

Automatic Signals for Street and other Secondary Railways (Sicherungen im Kleinbahn- und Strassenbahn-Betriebe durch Selbstthätige Scheiben-, Licht- und Glockensignale). An illustrated description of electric signal apparatus, visible and audible, which can also be applied to standard railways, and is independent of the motive power. 2000 w. Ill Zeitschr f Klein u Strassenbahnen—Jan. 1, 1902. No. 46903 C.

Steel Wheels.

Steel Street Car Wheels. W. L. Wright. Reviews the difficulties encountered in making a satisfactory steel wheel for street cars, and discusses the requirements of an ideal wheel. 1500 w. St. Ry Jour —March 1, 1902. No. 46769 D.

Stray Currents.

The Injury of Metal Pipes by Electric Railways (Zur Frage der Gefährdung von Metalleitungen durch Elektrische Bahnen). R. Ulbricht. A mathematical discussion of the dangers of electrolysis of underground pipes by stray currents from electric railways. Diagrams. 3000 w. Elektrotechen Zeitschr—March 13, 1902. No. 46959 B.

Surface Contact.

Surface Contact Electric Tramways at Wolverhampton. Illustrated description of a line equipped with the Lorain surface contact system. The construction is described in detail, also the rolling stock. 5000 w. Tram & Ry Wld—Feb. 13, 1902. No. 46588 B.

Suspended Railway.

The Barmen-Elberfeld-Vohwinkel Suspended Railway (Die Schwebebahn Barmen-Elberfeld-Vohwinkel). Hr. Petri. A paper before the Verein für Eisenbahnkunde giving an illustrated account of this railway, and of the advantages of suspended railways in general, with illustrations of one at Loschwitz near Dresden. 3000 w. Glasers Ann—Feb. 15. 1902. No. 46928 D.

Sweeper.

Sprinklers and Sweepers for Electric Tramways (Arroseuses et Balayeuses Electriques). A short illustrated account of a sprinkling trolley car at Lyons and a track-sweeping car at Paris. 700 w. Revue Technique—Jan. 10, 1902. No. 46361D.

Transporter-Trucks.

Conveyance of Standard-Gauge Stock Over Narrow-Gauge or Tramway Lines. Illustrated description of an arrangement for carrying standard-gauge cars on transportation trucks running on the small-gauge line. Trials have been made in France and are reported. 2700 w. Tram & Ry Wld—Feb. 13, 1902. No. 46590 B.

Trolley Automobile.

See Mechanical Engng, Automobiles.

Vibration.

Tube Railways and Vibration. A discussion of the statements in the recent report of investigations made in London, 2800 w. Engr, Lond—March 14, 1902. No. 47076 A.

Vibrations Caused by Underground Railway Trains. Summary of a report on the serious vibrations in buildings along the Central London Railway. 2300 w. Eng Rec—March 8, 1902. No. 46735.

Vibration on the Central London Railway. Extracts from the report of the committee appointed to investigate complaints of vibration in buildings adjacent to the Central London Railway. 2000 w. R R Gaz—Feb. 28, 1902. No. 46572.

Vienna.

Experimental Electrical Operation of the Vienna City Railway (Der Elektrische Probebetrieb auf der Wiener Stadtbahn). An illustrated account of successful experiments which will probably lead to the electrification of the road. 1000 w. Ill Zeitschr f Klein u Strassenbahnen—Feb. 1, 1902. No. 46905 C.

The Vienna City Railway (Die Wiener Stadtbahnen). A well illustrated description of this elevated and underground railway, at present operated by steam locomotive, but on which electrical operation is being experimented with. Serial. 2 parts. 3500 w. Schweiz Bauzeitung—Feb. 1, 8, 1902. No. 46994 each B.

We supply copies of these articles. See page 319.

EXPLANATORY NOTE.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* Boston, U. S. A.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Geologist. *m.* Minneapolis, U. S. A.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
Am. Manufacturer and Iron World. *w.* Pittsburg, U. S. A.
American Shipbuilder. *w.* New York.
American Telephone Journal. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. d Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *qr.* New York.
Architectural Review. *s-q.* Boston, U. S. A.
Architect's and Builder's Magazine. *m.* New York.
Armee und Marine. *w.* Berlin.
Australian Mining Standard. *w.* Sydney.
Autocar. *w.* Coventry, Eng.
Automobile Magazine. *m.* New York.
Automotor & Horseless Vehicle Jl. *m.* London.
Brick Builder. *m.* Boston, U. S. A.
British Architect. *w.* London.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bulletin Am. Iron and Steel Asso. *w.* Philadelphia, U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bulletin Scientifique. *m.* Liege.
Bull. Soc. Int. d Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Contemporary Review. *m.* London.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Electrical Age. *m.* *New York.*
Electrical Engineer. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical Times. *w.* London.
Electrical World and Engineer. *w.* New York.
Electrician. *w.* London.

Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Electrochemist & Metallurgist. *m.* London.
Elektrizität. *b-w.* Leipzig.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Cleveland, U. S. A.
Engineers' Gazette. *m.* London.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penn'a. *m.* Pittsburg, U. S. A.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f. Gewerbe & Bauwesen. *s-m.* Berlin.
Horseless Age. *w.* New York.
Ice and Refrigeration. *m.* New York.
Ill. Zeitschr. f. Klein u. Strassenbahnen. *s-m.* Berlin.
Indian and Eastern Engineer. *m.* Calcutta.
Ingeneria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron & Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Assn. Eng. Societies. *m.* Philadelphia, U.S.A.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery. *b-m.* Fort Monroe, U.S.A.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, Mass.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metal Worker. *w.* New York.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* Mexico.
Minerva. *w.* Rome.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. w. San Francisco, U.S.A.
Mining Journal. *w.* London
Mining Reporter. *w.* Denver, U. S. A.
Mitt. aus d Kgl Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. m. Vienna.
Modern Machinery. *m.* Chicago.
Monatsschr. d Wurtt. Ver. f Baukunde. *m.* Stuttgart.
Moniteur Industriel. *w.* Paris.
Mouvement Maritime. *w.* Brussels.
Municipal Engineering. *m.* Indianapolis, U. S. A.
National Builder. *m.* Chicago.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Wochenschr. f. d. Oeff Baudienst. *w.* Vienna.
Oest. Zeitschr. f. Berg- & Hüttenwesen. *w.* Vienna.
Ores and Metals. *w.* Denver, U. S. A.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Power Quarterly. New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Proceedings Engineers' Club. *qr.* Philadelphia, U. S. A.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Progressive Age. *s-m.* New York.
Quarry. *m.* London.
Railroad Digest. *w.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Review of Reviews. *m.* London & New York.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. ed Agr. *b-m.* Catania.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Sanitary Plumber. *s-m.* New York.
Schiffbau. *s-m.* Berlin.
Schweizerische Bzuzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Stahl und Eisen. *s-m.* Düsseldorf.
Steam Engineering. *m.* New York.
Stevens' Institute Indicator. *qr.* Hoboken, U.S.A.
Stone. *m.* New York.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago.
Telephone Magazine. *m.* Chicago.
Telephony. *m.* Chicago.
Tijds. v h Kljk. Inst. v Ing. *qr.* Hague.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. of Civil Eng. *m.* New York.
Trans. Am. Soc. of Heat & Ven. Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland Glasgow.
Transport. *w.* London.
Western Electrician. *w.* Chicago.
Wiener Bauindustrie Zeitung. *w.* Vienna.
Yacht. *w.* Paris.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a. S.

IMPROVED MACHINERY

New Processes and New Appliances

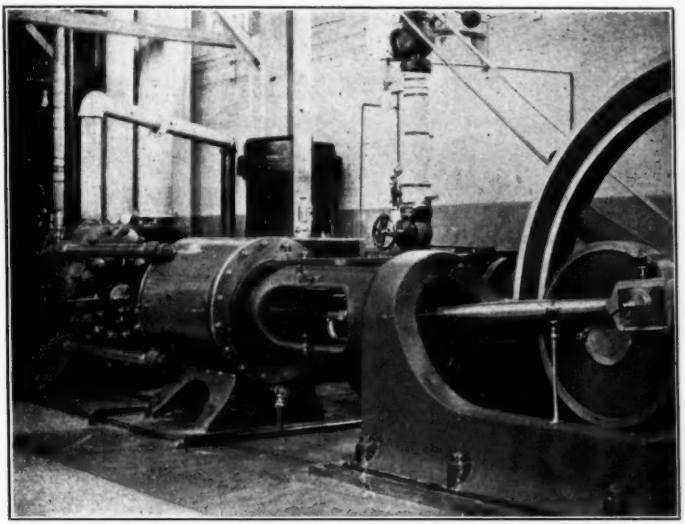
The matter here published is not paid for, nor can it be classed as advertising. But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

Franklin Air Compressor.

SINCE the discovery of the many practical usages to which the air compressor can be put, the rivalry in their manufacture among American manufacturers of that particular industry has been exceptionally keen. It is, perhaps, due more to this fact than to any other that a high state of perfection has been attained in their manufacture. One of the foremost manufacturers of compressors is the Chicago Pneumatic Tool Company of Chicago, Ill. At their Franklin air compressor works they are turning out a line of compressors which stand among the foremost.

The machine illustrated on this page shows their Class D. S. C. air compressor. It has duplex steam cylinders and two stage air cylinders, with inter-cooler. The cut is the reproduction of the machine they installed at Dunkirk, N. Y., for the American Locomotive Company in their Brooks plant.

This compressor has steam cylinders 20 in. in diameter by 24 in. stroke; low pressure air cylinder 27 in. in diameter by 24 in. stroke; and high pressure air cylinder 16½ in. in diameter by 24 in. stroke, representing a piston displacement of 1,580 cubic feet of free air per minute at a working speed of 100 revolutions.



A Safe Explosive.

THE recent disastrous explosion of dynamite in New York City and the ever-recurring premature explosions in mines and all operations of like nature, have been the chief instigators in bringing forward an

absolutely safe and flameless explosive, to which the inventors have given the name "Masurite." The claim of absolute safety and flamelessness has been proven many times,—one occasion being when the Safety Explosive Company, through their president, invited a number of engineers and explosive experts to witness safety tests to be made upon "masurite" March 22, at Sands Point, Long Island.

At these tests it was fully demonstrated to the satisfaction of the twenty-five guests present that masurite was absolutely safe from explosion either when subjected to fire or concussion, and would not explode except when fired by a strong fulminate of mercury cap. Double strength electric caps or fuses were used in all the detonation tests.

The experiments commenced with tests of the insensibility of masurite to concussion, and were as follows: One ounce of masurite was placed on an anvil and struck several sharp blows with a hand hammer. After this four ounces were placed on the anvil and struck a heavy blow with a 16-lb. sledge. These experiments were repeated, using a stone in place of the anvil for a base. A cartridge containing ten ounces of masurite was placed on the anvil and a 50-lb. weight was allowed to fall upon it from a distance of 25 feet. Cans containing 12½ lbs. of masurite were repeatedly fired into with a rifle, shooting mushroom and steel jacketed bullets alternately. A can containing about 10 lbs. of masurite, heated in contact with burning coal, was shot through as above, using mushroom bullets.

Next followed the fire tests, made by running a red hot iron, ¼ inch in diameter, through a cartridge of masurite. The powder was fused and burned directly in contact with the iron, but the fire did not spread. An inch iron heated to a bright red heat was inserted in a 10-lb. can of masurite with the same result as above. Masurite in cartridges and loose was thrown upon a forge fire; it fused and burned slowly, where in direct contact with the coal. When thrown upon burning charcoal and burning wood, the masurite burned only so long as the charcoal furnished the carbon for combustion.

A bundle of "parlor" matches was ignited in a heap of masurite, and the heat produced fused and burned the masurite in direct contact with the match heads. Masurite was covered with smokeless and with black powder and the two latter ignited; the positions were reversed, the black powder and the smokeless powder being covered with masurite, and the two former ignited and in all cases without ignition or explosion of the masurite. Quantities of masurite were thrown upon a red hot iron plate and burned slowly in a manner similar to that of sugar under like conditions.

A melting pot was filled with masurite, covered with an inverted funnel and heated upon the forge fire until fumes of decomposition were emitted, and these extinguished lighted matches held above the funnel.

Masurite rubbed vigorously between sand paper and emery paper resulted in no explosion.

Electric sparks from a 110-volt generator were next passed through and in contact with masurite without effect upon the powder. A fine copper wire was heated and finally fused by electricity in a heap of masurite, the only effect being to fuse the powder directly in contact with the melting wire.

To show that masurite could be exploded, a cartridge of masurite, with a double strength electric exploder, inserted in the ordinary manner, was detonated violently upon firing. Another cartridge with a similar exploder fastened to the outside, exploded as before.

To show that masurite cartridges can be exploded when in actual contact, two were taken,—one with an exploder, and one without, and placed with ends touching. Likewise seven cartridges, one with a fulminate fuse or exploder, and the remaining six without, were laid horizontally in a row with ends touching and all were completely exploded upon firing the cartridge with the exploder.

To show the insensitiveness of masurite to sympathetic explosion, two ten-ounce cartridges were placed 12 inches apart, and one exploded by means of the electrical fuse, when the other was found to have been torn by the explosion of the first, but not exploded or set afire.

To show the comparison between dyna-

mite and masurite a half cartridge of 40% dynamite was placed 12 inches from a cartridge of masurite and exploded in the usual manner, and the masurite cartridge was simply torn as in the previous test, but did not explode. A reverse test was made, by exploding the masurite with detonator or exploder, when the dynamite, 12 inches away, was exploded by sympathy, and emitted a bright flame.

In this test a comparison for flame could be made. The flame from the exploding dynamite was very brilliant, while no flame could be seen from the masurite. In fact in no case where masurite was exploded did it show any sign of flame.

At the termination of these tests a cartridge of masurite, which had been placed in a freezing mixture three hours previously, and which had been brought to a temperature of 6° Fahrenheit, was taken out and found to be as loose as at the beginning. This was exploded in the same manner as the others and behaved the same as they did.

After this, masurite was exploded in bore holes in a large boulder, which was thoroughly broken.

One of the chief values of masurite is its flamelessness upon explosion, as it can be used in gaseous coal mines without the slightest danger of igniting the fire damp or coal dust there.

For all general rock work its insensitiveness to concussion, jar, flame, and low temperatures renders it an extremely valuable discovery, as a means of terminating such catastrophes as the Rapid Transit Subway disaster in New York.

Masurite is being manufactured by the Masurite Explosive Company, New York City, successors to the Safety Explosive Company.

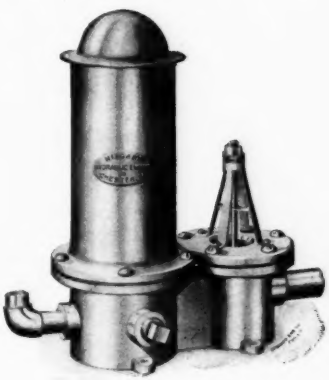
Hydraulic Engine.

THE hydraulic engine manufactured by the Niagara Hydraulic Engine Company, of Chester, Pa., is a modern development of the old-fashioned hydraulic ram, but it is as different from that clumsy machine as is an electric arc lamp from a tallow dip. The Niagara is a direct-acting machine and utilizes all the force of the water feeding it and it will force water regularly and steadily on a very slight "head" or "fall," to heights which hydraulic engineers formerly considered impossible.

Simplicity is the strong point of the machine and in it are combined all the good points of the old ram, along with a rectification of all its shortcomings. It is built in many sizes, from the little household supply machine to the powerful engine with a capacity sufficient to supply a town with water or irrigate great tracts of land.

It costs only a trifle as compared with a wind mill, a caloric or gasoline engine of the same capacity and, of course after it is once installed it works continually night and day, year in and year out, without the least attention.

It is adaptable anywhere where springs



streams, or running water are found. Distance and elevation are not insurmountable obstacles if there is any fall of water to depend on. A little ram installed at a country home in Virginia is pumping water a quarter of a mile and to an elevation of fifty feet, and owing to the flatness of the meadow in which the spring is situated, the fall is only fifteen inches.

Its service to mills and factories, for railroad purposes, and for irrigation where a large supply of water is necessary is equally efficient, since the installation of a No. 12 machine will furnish from 200,000 to 300,000 gallons a day. The number of uses for a hydraulic engine such as the Niagara are

practically countless, insomuch as some new field is turning up every day. Any further information on the matter will be cheerfully furnished by the company.

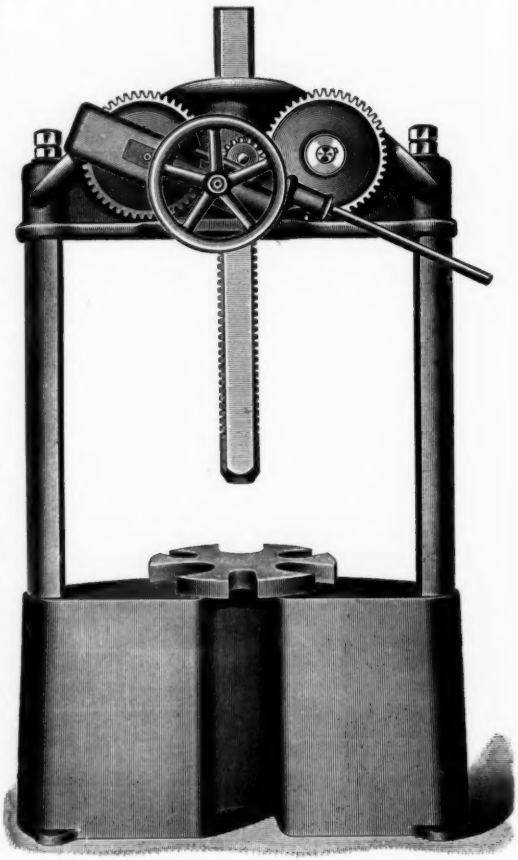
Heavy Arbor Press.

A NEW arbor press has been brought out by Edwin E. Bartlett, Boston, Mass., manufacturer of the Greenerd arbor press, which is of radically different design from the smaller presses previously manufactured by this firm. The new machine is to be known as the No. 8 Greenerd arbor press. It is powerfully geared with a leverage of 250 to 1, and it is expected that a pressure of between 15 and 18 tons will be realized at the end of the ram, with a man of ordinary strength at the lever. The ram is made of a piece of 4-inch crucible steel and has racks cut out on opposite sides. The gears are all of steel, the smaller being of hardened tool steel. The gears were designed especially for this press by the Brown & Sharpe Mfg. Co. The fact that the force applied at the lever is transmitted to the ram by two sets of gears, one operating in the rack on one side of the ram and the other on the opposite side, gives a powerful and uniform pressure to the ram throughout its whole travel. When the lever is at its highest position the pawl is freed from the ratchet and the ram is free to be moved in either direction by means of the hand wheel shown in front. It will be noted that the sides of the ram are recessed at the ends of the rack teeth, so that the teeth do not bear on the sides in the frame of the machine, which might prove detrimental and cause excessive wear. The press weighs about 2,000 pounds, and is designed for driving arbors up to 7 inches in diameter. There is a clearance of 36 inches between the uprights, and 35 inches between the plate and the top of the frame.

This press is being used by those who have them for pressing in crank pins, bushings, etc., and for straightening shafts, and numerous other uses which arise in machine shop practice.

The Stow Multi-Speed Motor.

THE new type of four-pole "multi-speed" motor, illustrated herewith, combines all the advantages of the ordinary multi-polar motor with the added advantage of an operative speed range of 100 to 150 per cent. from minimum speed, the percentage of speed variation increasing with the size of the machine. The armature rotates in a balanced magnetic field under all conditions of speed, this magnetic balance being secured by a simultaneous ra-



dial adjustment of the four plungers by means of bevel gearing, a hand wheel by which the plungers are moved being located conveniently at the top of the machine. It is the product of the Stow Mfg. Co., of Binghamton, N. Y.

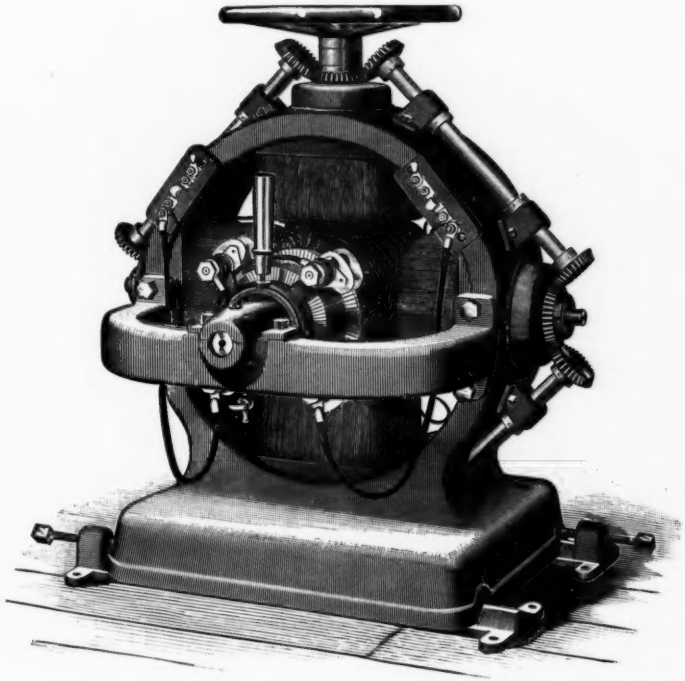
The design of the pole pieces and the selection of gearing is such that no great effort is required at the hand wheel in order to move the plungers against the tractive power of the field magnets. As the gears are small and the gear rods lie close to the frame of the motor, this mechanism does not detract from the otherwise symmetrical and pleasing design of the machine.

In common with other closely designed multi-polar machines, the various parts of the machine are arranged very compactly and the design secures a substantially reduced weight at a given speed over the bi-polar form.

The base of the motor is cast integral with the frame, and is provided with V slots at each of the corners, the rails being adapted to fit within these slots.

While the cut shows an open type machine, the design is such that if an enclosed motor is desired the armature supporting brackets may be removed and the ends of the frame finished so as to receive suitable enclosing heads, in the center of which the armature bearings are arranged.

The 6 H. P. machine shown in the cut is designed for a minimum speed of 700 R. P. M. the maximum speed being 1,500 R. P. M. giving a total speed variation of 115 per cent. at any speed between which limits the machine develops its full rated H. P. with an efficiency of only 2 per cent less at its maximum than at its minimum speed. This justifies the statement that the motor may be operated at any imaginable speed within the limits of 115 per cent variation, the efficiency of the motor at a given load being practically independent of the speed at which it is operated.



The construction of the pole piece and plunger of the multi-polar motor is similar to that used in the bi-polar form, the field strength, consequently the armature speed, being varied in accordance with the position occupied by the pole-piece cores or "plungers."

When the plunger is adjusted so that its inner end comes in contact with the pole shoe, the magnetic circuit is most complete and of minimum reluctance, and, since the M. M. F. of the field coil remains constant, the volume of magnetic flux becomes a maximum and the speed minimum, or normal. As the plunger is being drawn away from contact with the pole shoe a column of air is interposed which gradually increases the reluctance of the magnetic circuit as long as the plunger continues to be withdrawn. When the plunger reaches the limit of its outward motion, the reluctance of the magnetic circuit, and hence the speed, becomes maximum.

In regard to the fineness of speed adjustment, it is evident from the construction of the machine that there is no speed between maximum and minimum, which cannot be obtained by an appropriate adjustment of the hand wheel. While the motor carries its full load, sparklessly, at an imaginable speed within its range at practically maximum efficiency, it will also carry any lesser load with a consumption of power corresponding with the actual work done.

This machine represents a type which is being built in sizes from 5 H. P. to 25 H. P. For sizes above 25 H. P. automatic means can be furnished for varying the speed.

It is interesting to note that in many other motors the number of operative speeds corresponds to the number of steps in the controlling device, while the motor herein described possesses a speed range of absolute continuity; in other words, between the maximum and minimum limits an infinite number of speeds may be obtained, without the use of any "controller" or rheostat whose parts, however well made, are liable to become burned or otherwise deranged by use.

"Keystone" Hair Insulator.

AN article of exceptional interest to architects, builders and prospective owners of all kinds of structures is "Keystone" hair insulator. The problem of insulating buildings against the extreme temperatures of summer and winter is receiving considerable attention. Such an insulator not only insures greater comfort, but decreases fuel bills.

The question of sound deadening is also one of increasing importance in the residence, school, church, hall and, in fact, all kinds of buildings. The insulation of ice-boxes, cold storage compartments and buildings to maintain low temperatures produced by natural ice or refrigerating process is also a problem of great importance.

Several materials have appeared for the above purpose, and one of the most successful and economical is the "Keystone" hair insulator. In a paper upon insulation of cold storage presented at the October convention of American Warehousemen, at Buffalo, Mr. John E. Starr demonstrated the "Keystone" to be from twenty to forty per cent. superior to other materials in the various constructions commonly employed.

The exclusive selling right for "Keystone" hair insulator, patented and manufactured by Messrs Julius De Long & Co., of Allegheny, Pa., has been secured by the H. W. Johns-Manville Co., who are carrying stocks in various parts of the country.

The H. W. Johns-Manville Co. are recognized the world over as pioneers in the field of heat and cold insulation. So successful have been their products from asbestos and other materials that the marketing of "Keystone" under their name is sufficient guarantee of its adaptability to the work for which they recommend it. Pamphlets with additional information on the subject of "Keystone" hair insulator for the heat insulation and sound deadening of ordinary buildings, also upon refrigeration, together with samples of material, will be furnished upon request to the H. W. Johns-Manville Co., New York.

Recording Water-Level Gauge.

THE Bristol Company of Waterbury, Conn., are placing upon the market an adaptation of their well known recording pressure gauge to an instrument for making a continuous record in ink upon a revolving chart, of the rise or fall of the level of water in a canal, reservoir, well, tank, or variations of sea level.

The construction and operation of the instrument will be readily understood by reference to the illustration shown herewith. *A* represents the union joint by which a flexible capillary tube *B* is connected to the recorder. This connecting tube terminates in the upper portion of the bulb casting *E*, and when the instrument is in operation it is immersed to the depth a record is desired. chart on the recorder is graduated into feet or inches head of water, or of the liquid which is being measured and it may be adapted to almost any desired range.

The upper casting of air-bulb is provided with an eye for a cable suspension. The air bulb is also shown with a flange resting on a ring bracket *C*. This bracket is designed to be secured to a plank *F*, which

Between the flanges of the upper and lower parts of the bulb, *E* and *D*, a flexible diaphragm (convex downwards) of thin sheet rubber is firmly held, inclosing the proper amount of air for the operation of the instrument. Near the bottom of the lower casting *D* there are several holes for admitting water, the pressure of which acts upon the lower surface of the diaphragm, producing on the inclosed air a corresponding pressure due to its depth below the surface. The variations of the air pressure thus produced are communicated by means of the capillary tube to the recorder. The may be lowered into the water to any desired depth.

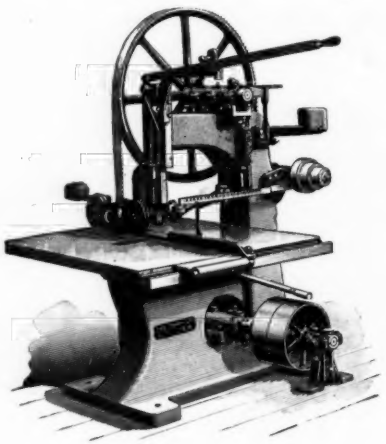
The recorder may be located at any convenient point for observation, either above or below the surface of the liquid to be recorded. The accuracy of the instrument is not affected by the location of the recorder or by the length of the capillary connecting tube.

An important advantage that instruments of this form have over those of ordinary type which are operated by floats, is that its continuous performance and accuracy cannot be affected by ice in winter.

Improved Band Rip Saw.

THE J. A. Fay & Egan Co., of Cincinnati, are manufacturing an improved band rip saw which they claim is the foremost machine in this line on the market. They base this claim on its great scope of work without the change of blades, by means of simple adjustments.

It will rip either hard or soft wood 1 to 10 inches thick without changing blades, and all the different adjustments are made easily, quickly and accurately. It will rip 24 inches wide. It will accomplish the work of several circular rip saws, and is besides much safer to operate, as there is no danger of the stock striking the operator. Owing to the thinness of the saw blade the slight saw-kerf removed is a



point in saving which will be readily appreciated by all users of fine lumber.

The straining device, used in connection with the top wheel hanging on a knife edge balance, insures at all times under all ordinary conditions a perfect tension on the saw blade, one of the most important points on a band saw to prolong its life.

The feed is very powerful and steady, and the feeding-in and feeding-out rolls being close together short stock can be worked to advantage. By a single movement of a lever the machine can be used as a hand feed rip saw. For establishments where flooring is made in large quantities, the machine can be fitted with a long table supporting rolls for returning the material for the next cut, thus saving much valuable time and attention.

Further particulars of this improved rip saw, together with terms and cuts, will be willingly furnished by the makers, who will also send free of charge to those interested, their new illustrated pamphlet on the care and erection of band saws.

Industrial Notes.

—In line with the general completeness and progressiveness of the Westinghouse Electric and Manufacturing Co., of Pittsburg comes the news of the formation of the Electric club, the membership of which is made up of the employees of the company. The organization was effected the latter part of March by the engineers and apprentices, for the most part college graduates, who felt the necessity for closer union and co-operation. At the inaugural meeting the constitution of the club was adopted by 150 charter members. Since that time the membership has nearly doubled. Comfortable and commodious quarters have been secured at 735 Penn Ave., Wilkinsburg, which include a lecture hall, reading, recreation and class rooms. The club is supported by the dues of the members supplemented by a subscription from the company. A board of nine directors exercises complete governing power over the organization. They elect all officers with the exception of the treasurer, who is designated by the company. Six of the directors are elective by the club from various departments, and the remaining three are appointed by the company. They are E. M. Olin, term expires Oct. 1, 1903, general representative; F. F. Rohrer, term expires Oct. 1, 1902, general representative; C. E. Skinner, term expires Oct. 1, 1903, Engineering Dept.; J. M. Hipple, term expires Oct. 1, 1902, Engineering Dept.; H. S. Day, term expires Oct. 1, 1903, Apprentices' Representative; E. D. Townsend, term expires Oct. 1, 1902, Apprentices' Representative; L. A. Osborne, C. E. Downton, and C. F. Scott, Company representatives. The Board has selected the following officers: President, E. M. Olin; Vice-President, E. D. Townsend; Secretary, C. E. Downton. The Treasurer appointed is L. A. Osborne.

—That employers are coming to realize the benefit of good treatment of employees in order to obtain the best results, is being demonstrated daily in all branches of manufacturing industries. The Simplex Electrical Company of Cambridgeport Mass., has taken one step further in the direction of making the employees of their big plant recognize the mutual advantage of faithful and efficient service. Early in the year the company divided among forty-six employees, who had been with the company for a stipulated number of years, the munificent sum of $3,000 as their share in the net earnings of the company for the preceding year. In the latter part of March some three hundred and fifty of the employes gathered at the lunch hour in a large vacant room of the plant and the Messrs. Morss, proprietors, were invited down stairs, where Mayor John H. H. McNamee of Cambridge, presented them with engrossed resolutions of thanks from and in behalf of the beneficiaries and employees generally of the factory. In replying to the excellent address of the mayor, Mr. Everett Morss, speaking for the firm, said that the company had not intended the profit-sharing arrangement as a piece of philanthropy, but as an act of business wisdom. Action of this kind on the part of the employers is bound to have the effect of causing the employees to realize that it is to their own as well as to the company's advantage to put forward their best efforts in their service.

—Mr. Ludolf Portong, president of the firm, The Schaeffer & Budenberg Mfg. Co., makers of steam specialties, of New York City, died Sunday, March 9, 1902. His son, Mr. A. L. Portong, has been elected to the presidency of the company.

—The offices of Blood & Hale, the well known engineering firm of Boston, Mass., have been moved from the Equitable Building to 10 Post Office Square, in the Delta Building.

—Mr. Hugh Calderwood, until the present time manager of the Collingwood Shipbuilding yards in Ontario, has recently resigned to accept a position in the same capacity with the Risdon Iron Works, of San Francisco.

—A special meeting of the stockholders of the General Electric Company has been called for the 5th inst., at Schenectady. It is rumored that the meeting has been called for the purpose of authorizing the issue of $19,757,800 of new stock. This will increase the outstanding capital stock to $45,000,000.

—The name of the Wellman-Seaver Engineering Co., a corporation of engineers and manufacturers, whose office and works are at Cleveland, O., has been changed to the Wellman-Seaver-Morgan Engineering Co.

—Mr. Francis Reed, who for some time past has been the head of the Geo. Burnham Co., of Worcester, Mass., has secured the change in the firm name to Francis Reed Co.

—The Chicago Pneumatic Tool Company have been so long located in the Monadnock Block that they have become pretty well identified with it, but owing to their requirements for greater office room, which they are unable to procure in that building, they have decided to remove to the Fisher Building May 1st. After May 1st they will be located on the tenth floor of the Fisher Building, corner of Dearborn and Van Buren streets, Chicago, where they will occupy very nearly the whole floor and will be glad to meet all their friends whenever they can make it convenient to call. Their New York office will remain, as heretofore, at No. 95 Liberty street.

—The largest order for pipe covering ever placed has been secured by the H. W. Johns-Manville Co. from the Pacific Coast Oil Co. (which is practically the Standard Oil Co.) who will lay about 280 miles of eight-inch pipe from Bakersfield to Point Richmond, on San Francisco Bay, to convey their oil to the coast. As the grade is very slight, pumping stations are necessary along the line. On account of the heavy nature of the oil it must be heated to a certain temperature before it can be pumped, and to maintain this temperature of the oil in the pipes between the pumping stations a non-conducting covering is necessary, and the H. W. Johns-Manville Co. are to supply the 280 miles of covering for this purpose, which, when ready for shipment to California, will fill 200 cars. The immense facilities of the H. W. Johns-Manville Co., at both their New York and Milwaukee factories, make it possible for them to successfully handle an order of this mag-

nitude, and a number of miles of the covering were in transit to Bakersfield within a few days after the order was received.

—The Northwest Steamship Company have been making rapid progress on the interior changes of their crack passenger boats "Northwest" and "Northland." These changes, although the steamers have only been in commission four years, include boilers of the Scotch Marine type, also many changes of the interior fittings. The estimated cost to reach nearly half a million dollars. Contracts for the most of this work have been awarded. On each boat there will be duplicate generating sets for electric lighting, consisting of two horizontal tandem compound engines made by the Buffalo Forge Company, direct connected with General Electric Company marine type 75 K. W. generators. The engines are of the Buffalo Forge Company latest type, and specially designed for this contract, the space available being limited. As the boats are to be put in commission at the near approach of lake navigation, the builders have agreed to deliver the engines in an extremely short time. In addition to the above, these boats are being fitted out with a complete set of the most improved ventilating apparatus for maintaining the air in all portions of the vessel uniformly cool and pure at all times. Six Buffalo steel plate fans with direct connected General Electric Company motors will be installed in each steamer with an elaborate net work of galvanized iron ducts for delivering the air. This system will be when completed in perfect accord with the balance of the magnificent equipments of these splendid vessels.

—The sixty thousand mark has been passed by the Pressed Steel Car Company of Pittsburg, Pa., in the manufacture of pressed steel cars. The company's output up to March 27th, 1902, aggregated over 60,000 finished cars, or sufficient to make a solid train 360 miles long. The cars built by this company have practically revolutionized the present methods for freight car transportation, the pressed steel car being much lighter in proportion to the carrying capacity than the old style wooden cars in use prior to 1897. The works of this company are pushed to their fullest extent, delivering over 100 finished cars per day, in addition to a large number of trucks, bolsters, center plates, and other pressed steel specialties for wooden and steel cars.

—Pawling & Harnischfeger, Milwaukee, Wis., advise that the demand for electric traveling cranes continues satisfactory in every way. They have recently booked orders for 45 cranes and hoists, among which are representative firms as follows: Henry Vogt Machine Co., Louisville, Ky., one 5 ton, two 10 ton and one 15 ton; Oil Well Supply Co., Oil City, Pa., one 2 ton; Wheeling Steel & Iron Co., Wheeling, W. Va., one 7 ton; Allis-Chalmers Co., (Fraser & Chalmers Plant) Chicago, one 20 ton, with 5 ton auxiliary; Allis-Chalmers Co., (Gates Plant) Chicago, one 50 ton with 5 ton auxiliary; Bradley Mfg. Co., Allegheny, Pa., one 6 ton; Fairbanks, Morse & Co., Beloit, Wis., one 15 ton; Colorado Fuel & Iron Co., Bessemer, Colo., one 10 ton, one 20 ton; Newport News Shipbuilding & Dry Dock Co., Newport News, Va., two 20 ton; Whitney Iron Works Co., New Orleans, La., one 10 ton, one 20 ton; American Bridge Co., Philadelphia, one 20 ton, double trolley; Pittsburg Plate Glass Co., Pittsburg, two 3 ton; American Sheet Steel Co., W. Dewees Wood Co. Dept., McKeesport, Pa., two 5 ton; Structural Steel Car Co., Canton, Ohio, one 12 ton; The American Well Works, Aurora, Ill., one 10 ton; Norton Emery Wheel Co., Worcester, Mass., one 10 ton; Lackawanna Iron & Steel Co., West Seneca, N. Y., one 3 ton; Follansbee Bros. Co., Pittsburg, one 5 ton, one 10 ton, with 3 ton auxiliary, and one 25 ton; The Vulcan Works, Chester, Pa., one 15 ton, with one 5 ton auxiliary; Northern Central Railway, York, Pa., one 25 ton; The Midvale Steel Co., Philadelphia, one 10 ton jib; The Standard Steel Works, Burnham, Pa., five 5 ton and one 15 ton; American Sheet Steel Co., Wellsville Works, Wellsville, Ohio, one 30 ton with 5 ton auxiliary; The Trenton Iron Co., Trenton, N. J., one 3 ton; Wm. B. Pollock & Co., Youngstown, Ohio, one 20 ton riveter with 5 ton auxiliary.

—The St. Louis branch of the H. W. Johns-Manville Co. report having secured the contract for Pipe Covering in the new Bank of Commerce Building, Southeast corner Broadway and Olive Street, St. Louis, Mo. The material used on all main pipes and risers is asbesto-sponge moulded

covering, and the breachings and hot water tank will be covered with their magnesia. The total cost of the above contract will be close on to $1,000.

—The American Diamond Rock Drill Company have moved into larger and more commodious offices. Their address will be 95 Liberty street.

—The New Jersey Zinc Co. of New York have placed an order with the McKiernan Drill Co., for two Cross compound corliss air compressors. Each compressor has a capacity of 6,534 cubic feet free air per minute. They are to be installed in the company's mines at Franklin Junction, N. J. An expenditure of $50,000 is involved in the transaction.

—The spring meeting of the Engine Builders' Association of the United States will be held May 22nd and 23rd at Hotel Schenley, Pittsburg, Pa. The programme is as follows: Meeting of the Council at 10 A. M. on May 22nd; open meeting for hearing of papers especially prepared, 2 P. M., May 22nd; business meeting of the association 10 A. M., May 23rd. The afternoon of May 23rd will be devoted to a visit to the Westinghouse Machine Co.'s plant. At 6 P. M., May 23rd, the usual banquet.

NEW CATALOGUES AND TRADE PUBLICATIONS

These catalogues may be had free of charge on application to the firm issuing them. Please mention The Engineering Magazine when you write.

Acetylene Lamps.

Attractive catalogue of the latest thing in acetylene lamps designed for use in mines. Tables of comparison in price of acetylene lighting over other lights. A proposition worth investigating by mine operators. Tables of size and prices. For general distribution. A. H. Funke, 101 Duane street, New York.

Asbestos Covering.

Booklet for 1902, entitled "A Modern Method of Steam Saving." Shows the latest type of steam pipe covering of asbestos at a moderate cost. Price lists. For general distribution. F. J. Gast, 26 Cortlandt street, New York.

Blast Furnaces, Gas.

Catalogue for 1902 (sixth edition), illustrated, showing the several types of fuel gas plants, gas blast furnaces, positive pressure blowers and heating machines, for use exclusively in industrial establishments. Price lists. For general distribution. American Gas Furnace Company, No. 23 John street, New York.

Blowers.

New catalogue, illustrated, of the "Reichhelm" high pressure blower. Cross section drawing of the machine, with full description of parts. Contains table of capacity and prices. For general distribution. E. P. Reichhelm & Co., 23 John street, New York.

Boilers.

Catalogue for 1902, attractively printed, treating boilers of all types of latest designs, stand pipe tanks, and all kinds of plate and sheet iron work. Tables of capacity, etc. Sectional views of construction. Code of rules for the care of boilers of advantage to engineers and firemen. For general distribution. Springfield Boiler & Mfg. Co., Springfield, Ill.

Computing Machines.

Small, attractive booklet, entitled, "The New Idea Calculator." Small, compact machine which the manufacturers claim does away with all the bad points of other calculators on the market. Constructed for both time and piece work systems. For general distribution. Carlton Mfg. Co., 76 Franklin street, New York.

New catalogue showing machine for computing addition, multiplication, subtraction, and division, entitled "Mechanical Arithmetic." Device is exceptionally useful in counting house departments, railroad offices and any-

where exhaustive accounting is necessary. A labor-saving device in line with the general advancement of the day. Price list. For general distribution. Felt & Tarrant Mfg. Co., Chicago, Ill.

Core Drilling Machines.

Series of folders issued in the interest of core and other systems of drilling. First is entitled "Comparative Merits of Various Methods of Prospecting;" second treats the Preslar combination core and well drilling machine; the third is on the Preslar perfect friction clutch pulleys and couplings. All illustrated. For general distribution. C. F. Preslar Mfg. Co., Cincinnati, Ohio.

Crushing and Grinding Machinery.

Handsome catalogue given over entirely to the subject of all types of crushing and grinding machinery of the latest design. Fully illustrated; sectional views of the machines. For general distribution. Sturtevant Mill Co., Boston, Mass.

Drills.

Catalogue and price list for 1902. Illustrated with full description of machines and parts. Code. For general distribution. Francis Reed Company (successors to the Geo. Burnham Co.), Worcester, Mass.

Small, attractively arranged booklet, treating the "Kecht" sensitive friction drill. Variable speed without cone pulleys or shifting belt. Illustrated. For general distribution. The Kecht Brothers Co., Cincinnati, Ohio.

Electrical Driven Grinders.

Small booklet, illustrating and explaining the advantages secured through the use of the "Hisey" electrical driven grinding machines. Of interest to foremen of the machine shop, tool room and foundry. For general distribution. The Hisey-Wolf Machine Co., Cincinnati, Ohio.

Electric Motors.

Bulletin No. 301 for March, 1902, treating "Lundell" motors designed specially for driving ventilating fans and blowers. Illustrations show line of standard make blowers and fans, direct connected with Lundell motors. Computing tables of capacity of several types of machines. For general distribution. Sprague Electric Company, New York.

Electric Propulsion.

Attractive catalogue, fully illustrated, with full description of the conditions which lead up to the solving of the underground electric wire system for transportation. Sectional views of the conduits, and manner of transmitting power to the motors. A revolution in electric transportation. For general distribution. The Union Electric Construction Co., the Bourse, Philadelphia, Penna.

Electric Surgical Instruments.

Bulletin No. 16, illustrated, showing the latest design in electrical driven surgical instruments. Also electrical driven dental instruments. Full price lists. For general distribution. Victor Electric Company, Chicago, Ill.

Engraving Machines.

Form No. 172, treating No. 1 engraving machine for cutting, lettering or designs, either sunk or in relief on metals or other materials. Also form No. 174, containing instructions, with cross section drawings for the erection and operation of No. 1 machine. For general distribution. George Gorton Machine Company, Racine, Wis.

Fan Motors.

Very handsome catalogue for 1902, fully illustrated, showing the Western Electric Company's fan motors of the latest pattern. Full page illustrations of all types of desk, bracket, and ceiling fan motors, with sectional views of each. Contains some very handsome designs in ceiling fans. For general distribution. Western Electric Company, Chicago, Ill.

Catalogue No. 304, of extremely handsome design, showing company's latest designs in desk, bracket and ceiling fan motors. Also demonstration of small exhaust fan made by the company. Full telegraphic code. For general distribution. Sprague Electric Company, New York.

Gas Plants, Fuel.

Descriptive pamphlet, (fifth edition) with description of the plants, price of installation, and treatises on "Gas Power" and the "Relative Value of Different Fuels." Naphtha and crude oil for the purpose of making gas discussed. References. For general distribution. Ameri-

can Gas Furnace Company. No. 23 John street, New York.

Insurance Rates.

Well printed booklet, entitled "Ready Reference Insurance Rates for Fire Proof Buildings." Information contained is set forth very compactly. Taken from official fireproof insurance schedule. For general distribution. Henry Maurer & Son, 42 East 23rd street, New York.

Locomobiles.

Very handsome catalogue in Spanish of the very latest designs in steam machines, showing the different classes of machines. Profusely illustrated. Contains photographs of the company factory and work rooms. For general distribution. The Locomobile Company of America, 7 East Forty-second street, New York.

Marine Craft and Machinery.

One of the handsomest catalogues of its kind ever printed. Handsomely engraved illustrations, with interesting descriptions of boats and machinery shown. Bound in two sections under one cover. The first treats steam launches and marine machinery, and the other naphtha launches, yachts and tenders. Gas Engine and Power Company, and Charles L. Seabury & Co., consolidated, Morris Heights, New York.

Mechanical Draft.

Bulletin 46, small, illustrated, entitled "Mechanical Draft. What It Does." But recently issued. The story of the advantages of mechanical draft over any other system, irrespective of great difference in costs of construction, briefly told. For general distribution. The B. F. Sturtevant Co., Boston, Mass.

Mechanical Drawing.

Illustrated circulars, on Nos. 1, 2 and 3 of the "Rich" handy drawing outfit. The device is compact and in convenient form for anyone who is compelled to go outside to take measurements. For general distribution. J. & G. Rich, 120-122 N. Sixth Street, Philadelphia, Penna.

Milling Machines.

Series of circulars on different types of milling machinery. Circular C, treating combined punch and shear; Circular E, forming rolls; Circular N on gap shears; Circular R on automatic opening, closing and self adjusting rolls; Circular L on cornice makers' squaring shear; also undesignated circular on hydraulic bending machine and improved plate shear. All illustrated. For general distribution. Bertsch & Co., Cambridge City, Ind.

Substantial catalogue, for 1902, (domestic edition) treating all manner of milling machines and cutter grinders. Profusely illustrated, showing machines and machine parts. For general distribution. The Cincinnati Milling Machine Company, Cincinnati, Ohio.

Mining Machines.

Substantial catalogue of all the latest designs in electrical coal mining machinery. Each machine illustrated and with it illustrations of all the machine parts. Complete telegraphic code for duplicate parts. For general distribution. Morgan-Gardner Electric Co., Chicago, Ill.

Motors and Generators.

Bulletin No. 1020, on the subject of the "Wood" system belted direct current multipolar generators. Fully illustrated with complete description of the machine and parts. Bulletin No. 1021 on the "Wood" system belted direct current multipolar motors. Illustrated, full description of machine and parts. Tables of size and specifications. For general distribution. Ft. Wayne Electric Works, Ft. Wayne, Ind.

Oil Filters.

New booklet on the subject of the Hanover oil filter. A distinctly American machine astride with the times. Owing to the advancement in construction it is very easy to clean. An up-to-date device for cutting down the lubrication bills. For general distribution. W. S. Haines Company, 18th and Hamilton street, Philadelphia, Penna.

Catalogue (recent issue) entitled "White Star Filtering System. Details of the working parts of the White Star filter, with illustrations. For general distribution. Pittsburg Gage & Supply Co., Pittsburg, Pa.

Pipe-Threading Machinery.

Large, well printed, illustrated catalogue for 1902, indexed, on the general subject of pipe threading, with illustrations of all designs of tools. For general distribution. D. Saunders' Sons, Yonkers, N. Y.

Pneumatic Tools.

General catalogue (just issued) gotten up in a very attractive manner, with illustrations showing the instruments treated in general use. Replete with useful information regarding the tools. Tables of capacities, weights, dimensions, air consumption, etc. Of exceptional interest to buyers and users of pneumatic tools. For general distribution. Philadelphia Pneumatic Tool Company, Philadelphia, Penn.

Pumps.

Catalogue B, profusely illustrated, with tables of capacity, pressure and velocity. Simplicity, durability, handiness, reliability, efficiency and economy claimed. Illustrations of the pumps in actual use. For general distribution. The Emerson Pump Co., Washington, D. C.

Two attractive catalogues for 1902. Subjects: "Screw Pumps;" and "House Service Pumps." First treats simplicity and durability, the efficiency, lack of pulsations, absence of internal friction, and the important fact of pump's ability to handle thick liquids. Second treats efficiency of house service pumps, and cheapness of maintenance as expert attendance is not required. For general distribution. William E. Quimby, Inc., 86 Liberty street, New York.

Railway Materials.

Small, three-page folder, illustrated, showing different kinds of narrow guage cars for use in foundries and manufacturing plants. M. H. Treadwell & Co., 95-97 Liberty street, New York.

Shaking Grates.

Small, attractively printed catalogue, well illustrated, showing the "Tread-Kill" grates. Illustrations of grate installed and grate parts, with full explanations. For general distribution. M. H. Treadwell & Co., 95-97 Liberty street, New York.

Special Lighting Apparatus.

Part one, discussing projection optics for pictoral projection, and spectacular effects. Lights for commercial and marine purposes; Part two, entitled "Artificial Sunlight," discussing isolated gas lighting plants. Lights for vehicles, bicycles and yachts. Acetylene gas. Bullard & Breck, 131 Post street, San Francisco, Cal.

Steam Specialties.

Small folder on the general subject of steam specialties, but treating especially "Stephenson Bar Belt Dressing." Efficiency, convenience and economy claimed. "National" lubricators and "Rollins" self-expanding flue cleaner, illustrated. For general distribution. Stephenson Mfg. Co., Albany, N. Y.

1902 Catalogue, well printed, illustrated, showing all types of reducing valves and other steam specialties. Also contains latest improved pressure regulators for water, gas, and air. Quarter-section of several types, showing interior construction. For general distribution. The Foster Engineering Company, Newark, N. J.

Storage Batteries.

Bulletin No. 70, treating the extreme economy derived from the application of storage batteries to railway plants. Interesting to electric railway officials. For general distribution. The Electric Storage Battery Co., Philadelphia, Penna.

Trip Hammers.

Illustrated circular, No. 50, with full description of the machine parts and capacity. Designed specially for blacksmithing. Advantages of construction shown. For general distribution. Mayer Bros., Mankato, Minn.

Typewriters.

Catalogue No. 3, well printed, profusely illustrated, treating the many advantages of the Oliver typewriter, for use in all lines of business. Especially adapted for use in railroad and telegraph offices. Interior views of the factory and offices. For general distribution. The Oliver Typewriter Company, Chicago, Ill.

Valves.

Substantial catalogue, bound in cloth, indexed, with complete telegraphic code. Catalogue is composed of 256 pages, showing every type of valve manufactured. The Eddy Valve Company, Waterford, Conn.

Vises.

Illustrated circular, demonstrating the patent quick action vises, designed for wood working, cabinet making, and pattern maker. Construction of the device shown in cuts. For general distribution. Wymen & Gordon, Worcester, Mass.